SURGERY
GYNECOLOGY AND OBSTETRICS
An International Magazine, Published Monthly

VOLUME 68 JANUARY, 1939 NUMBER 1

PURPOSEFUL SPLINTING FOLLOWING INJURIES OF THE HAND

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NO discussion of the importance of rest in the treatment of injured hands and of methods of securing it would be complete without an acknowledgment of our indebtedness to the teachings of Hugh Owen Thomas; and it is fitting to remind ourselves again of the extent of that obligation.

The story of Hugh Owen Thomas goes back more than 200 years when a dark complexioned Welsh boy,[1] Evan Thomas by name, began to show a special aptitude for caring for the sick and injured animals about the farm. As he grew older his reputation spread; and, reversing the procedure of the famed Dr. James Doolittle, who found animals more to his liking than humans, Evan Thomas gradually developed a practice among the farmers of the countryside, a practice which eventually extended over North Wales and neighboring parts of England. On his death, in 1814, a tablet was erected to his memory

"... who, in humble life, without the aid of education or any other advantages, by an extraordinary gift of nature, acquired such a knowledge of the human frame as to become a most skilful Bone-setter, whereby he rendered himself pre-eminently useful to his fellow-creatures."

Evan Thomas was followed by five sons who carried on his work. Of these, Richard, considered the most skilful, had three sons and four daughters. Except for the eldest, Evan, they carried on the family tradition in their own neighborhoods. Evan at the age of 19 went to Liverpool to seek wider fields for his talents. He began by treating the injuries of his fellow workers in the foundry where he had found an opportunity to work, and so successful was he that he soon was able to set up in practice as a bonesetter. He developed an extensive following among the dock workers and laborers of Liverpool. Here, in 1832, he married a Miss Roberts, and here his five sons were born, of whom the eldest, Hugh Owen Thomas, born August 23, 1834, is our hero.

Hugh Owen was a silent lad of rather frail physique, but an ardent student and a lover of books and nature. An intellectually gifted and greatly loved mother and a thoughtful, kindly schoolmaster were potent factors in developing the idealism, the stern sense of duty, the constant self criticism and unwillingness to be satisfied with any achievement short of perfection, the love of poetry and music which were outstanding characteristics of the boy and man.

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[1] There is an oft repeated legend that Evan Thomas was of Spanish descent, the older of two brothers, sole survivors of a shipwreck on the rocky coast of Angelsea in Wales.

From the age of 13 to 17 he attended the college at New Brighton; and subsequently was apprenticed to his maternal uncle, Dr. Owen Roberts, surgeon to the Workhouse Infirmary at St. Asaph. This association with a stimulating personality, a physician with an extensive practice and a scholarly mind, was another fortunate opportunity for this earnest young student.

Evan Thomas, the silent serious minded father, wisely and generously decided that his sons should have a medical education and become qualified practitioners. Wisely, because the constantly increasing friction with the medical profession and the handicaps under which he himself labored as a result of his limited medical training made him realize that the opportunities for the bonesetter were steadily diminishing; generously, because he must have foreseen that eventually it might mean a parting of the ways between the unschooled bonesetter and the sons educated in the most advanced medical institution of his day. Such a parting from his eldest son eventually came, with sorrow and unhappiness for both.

At the age of 21 Thomas entered the University of Edinburgh. Symes, Spence, Simpson and Goodsir then held professorships; Lister was house surgeon to Symes. There, in rooms on the top floor of one of the tall houses so common in Edinburgh, on an allowance of ten shillings a week, he lived during the two years of the prescribed medical course. Nothing impressed him so much as the number of amputations constantly performed for inflammation and diseases of the joints—conditions he had seen so often successfully managed by conservative treatment in his father's practice.

After two years at Edinburgh, twelve months at University College in London and a period of study in Paris he joined his father in practice at Liverpool. Before two years had passed the parting of the ways came and in 1859 Hugh Owen set up in practice for himself at 24, Hardy Street.

Soon he was as busy as his heart could wish. A number of clubs and organizations of workingmen chose him as their medical officer. In 1866 he was compelled to seek larger quarters and moved to the house at 11, Nelson Street—the house which has become almost a shrine to every man interested in the surgery of the extremities, the bones and joints. To it he added consulting rooms and a workshop, the latter fitted with every possible appliance for fashioning the splints which played so large a part in his treatment of injuries and diseases of the bones and joints.

His nephew, Sir Robert Jones, who joined him as an apprentice at the age of 15, has left this graphic picture of the man and his work:

"In appearance Hugh Owen Thomas was a striking figure. He was thin and pale, about five feet four in height. His features were refined and clear cut, with an intellectual forehead which receded slightly, and dark-grey eyes which were capable of great expression, sometimes sad and thoughtful, but often alert and full of fire. His slight moustache was dark and his spare beard pointed. He always wore a closely buttoned black frock-coat and a peaked cap, to shelter his tender eye[1] from the light. His manner had been described as brusque, but it was not so. He was quick and abrupt, and fired his questions and answers briskly, but he never repelled. He was beloved by children. Always a good listener and most tolerant of criticism, he had no patience with dogmatic fools.

"A personal sketch . . . would not be complete without an average day's work, from early morning till late at night. At six o'clock in the morning he was mounted in a dog-cart which had been built by his own smith, to his own design, on his own premises. He had a list of ten or twelve addresses to be visited before breakfast. It often happened that when he knocks at the door, usually with his bare knuckles, an empty milk can was handed to him. But as a rule they knew his knock. The patient may have a broken leg, intestinal obstruction, or pneumonia. There was always time for a cheery word of advice and admonition. If it was a broken thigh the extensions might want tightening, pressure pads adjusted, and many warnings were sure to be given to the household that no bandage was to be meddled with. Another house, and he might find that the bandage *had* been loosened in a case of Pott's fracture. The surgeon stormed, and the patient was immediately penitent. He was no longer to be trusted, however, so the bandage is reapplied and a large pin fastens it, but before the surgeon leaves a large blob of sealing wax covers the pin and with a signet ring removed from his finger it is sealed with the initials H.O.T. Another visit, and Thomas might be seen carrying a boot in one hand and a box containing enormous cutting shears in the other hand. He is about to transform a bed-splint into a caliper in a case of tuberculous knee, for the time for walking has come. The bandages are undone and the ring of the splint is pressed hard upon the tuberosity of the

[1]An ectropion of the lower lid, resulting from an injury in childhood.

ischium: with suitable instruments the arm stems are cut and the ends introduced into the patient's boot. The whole operation is complete in less than five minutes. The boot has been prepared beforehand by having a tube placed in the heel and a vertical V-shaped gap cut out from the back of the upper while the front of the boot is slit up to the toe —all these preparations being essential to avoid friction. This, as Thomas put it, takes less time than it does for a smith to 'blow up his fire.' The next patient may be a case of intestinal obstruction who is visited five or six times a day. And so the round went on until breakfast, which consisted of a cup of tea and a couple of bananas. The meal rarely lasted for more than ten minutes, but he always found time to relate any comic adventure that may have occurred on the round, and to glance at the more important items in his morning paper.

"From nine until two he was at work in his room, where he met with every variety of case both medical and orthopædic. During the morning he saw between thirty and forty patients, prescribed and dispensed medicine for them, dressed their wounds, reduced their fractures and dislocations, and gave each one his individual attention. Long experience on the surgical side had enabled him to make a rapid diagnosis and to ask only those questions which had a direct bearing on the case.

"His methods of examination, although rapid, were very gentle. He had wonderful knowledge of the movements that give rise to pain and of the value of an accurate grip in steadying muscle and supporting a limb. Whenever he had to handle a fracture he persuaded the patient to abstain from all effort, and to leave the muscles slack, knowing full well how often pain is self-inflicted.

"There was hardly a morning without one or two cases of fracture, and these were always expeditiously dealt with without anaesthesia.

"The equipment of the establishment in Nelson Street was such that no outside aid was needed. There was a blacksmith at work in a smithy, a saddler finishing off the various splints, and duties of others were the making of adhesive plasters and bandages, and the preparation of dressings. There were splints of every size to suit any possible deformity that might appear or for any fracture that might have occurred. No matter from what distance a patient came, no matter whether the affection be spinal caries, hip disease, or fractured thigh, he was always able to return home in an hour or so, most accurately fitted with a simple and appropriate splint. . . .

"At half-past two people were seen at their homes without delay, for at 4.30 he must be back at Nelson Street.

"His last meal finished he hurried from the table to see his evening flock who continued to come until eight o'clock. Although most of these were Club members quite a number of them were surgical cases, but the patients had more confidence in him than in hospitals. In spite of his strenuous day he is bright and cheery, for he loves to chat with the working man on the character and scope of his work. Usually at eight he made his last round, confining his visits to those cases critical in themselves, or interesting from the point of view of investigation. It was always interesting because compound fractures and intestinal obstruction were often encountered.

"From nine-thirty to twelve he either worked in his lathe room, which was fitted with the most modern machinery, making new surgical instruments or repairing old ones, or he would find his way to the library to read and write.

"This, then, presented an ordinary day's work, and to anyone who knew Thomas, with his frail body and anxious mind, entering whole-heartedly into his patients' troubles and always unsparing of effort, it is a marvel how he could continuously work at such pressure for over thirty years—for it must be remembered that he never took a holiday. During all these years of work he was only away from home some six nights, and even on Sunday mornings he had his free clinic when nearly two hundred cases, many of them of great interest, collected from all parts. It was a great scene, and surgeons who were present never ceased talking of the marvels they had witnessed, for Thomas was years ahead of his time and the results of his treatment of fractures and tuberculous arthritis seemed then little less than miracles.

"He used to long for Sunday evenings, which he always devoted to music. His wife sang while he played the flute. These evenings gave him intense delight, for he was passionately fond of music and knew all the operas well, but the night nearly always closed with Welsh airs. In later years when he, as he put it, got 'too tired to blow' he went to bed early and read, while his niece played for him, and before he slept he always called for 'The Dead March in Saul.' He possessed three most beautiful silver flutes, and it is interesting to note that he specially designed some of the machinery of the stops to simplify the movements."

For thirty years he kept up this strenuous pace, happy in his work and in his home, presided over by his one confidant, the gracious and beautiful Elizabeth Thomas. Then, exposure to cold while on a consultation in a neighboring town, pneumonia of brief duration, death—January 6, 1891.

Thomas' claim to enduring fame is securely based on his logical and successful methods of treatment of disease—methods which were unknown to or unrecognized by his contemporaries, but which today are accepted as sound and correct. At the very basis of his treatment was the principle of maintaining complete rest of injured and inflamed tissues. Not only did he insist upon rest for injured and

inflamed joints, but for injured and inflamed bones, soft tissues, intestinal tract—for any tissue that was involved in injury or infection. With his recognition of the importance of rest he combined a mechanical genius and ingenuity for developing simple and effective methods of securing it, and an unwillingness to stop until he had made as perfect as possible the splint or device or method which would make certain of securing the desired rest.

Many factors conspired to prevent him from gaining the hearing and the audience he deserved. Most of his publications were privately printed and distributed. He had no hospital appointments or teaching affiliations. The antagonism of the members of the medical profession, many of whom considered him simply a bonesetter, his uncompromising attitude toward opponents and critics who knew little of his work, his lack of regard for medical authority, his naturally shy and retiring disposition, and, perhaps, most of all, the fact that he was so completely happy and so completely engrossed in the little world that centered at 11, Nelson Street, all conspired to deprive him of the hearing and recognition he deserved so well. It was the good fortune of the medical profession and the world of suffering humanity that he should have left behind him an able and trained protagonist, Robert Jones, who made the medical world conscious of the character and importance of his teachings.

Today the name of Thomas is associated in our minds chiefly with the famous hip splint and knee splint, described so carefully in his book, *Diseases of the Hip, Knee and Ankle Joints*. It is often forgotten that he was a general practitioner, interested in every phase of medical work. His treatment of intestinal obstruction was far in advance of his time. His régime of simple feeding and intestinal rest in the treatment of typhoid fever is accepted today as an essential part of the management of a disease which until only 25 years ago was the scourge of cities and armies. He was an expert lithotomist. His first publication was upon fractures of the jaw. So wide a field of medicine and surgery did he illuminate by his teachings and practice.

Earnest, honest, clear thinking, ingenious, devoted to his home and his work, beloved by the poor of Liverpool, who gathered in thousands at his funeral "stirred to their very depths by an emotion that found expression in passionate sobs and tears, as they lined the streets or pressed forward to gaze into the open grave,"[1] this little man of unquenchable fire and indomitable energy stands out as one of the truly great and wholly admirable figures of nineteenth century medicine.

[1] Lancet, 1891, 1: 174.

THE importance of rest in the treatment of injured tissues has been stressed by many surgeons since the time of Larrey.[1] The beginner in surgery recognizes its importance in the treatment of fractured bones. By a curious inconsistency, probably due only to failure of attention, he does not realize that rest for contused and lacerated soft tissues is just as essential if healing is to take place promptly and with a minimum of scar tissue formation.

[1] "Dominique—Jean Larrey (1766–1842), the greatest French military surgeon of his time, . . . served in the Napoleonic wars. In his will Napoleon left 100,000 francs to 'Larrey, the most virtuous man I have ever known.' . . . He was the originator of 'first-aid to the wounded,' in the ultra-modern sense, 'taking the hospital to the wounded' with his hundreds of ambulances, directly a battle was joined and not after it. Like Ambroise Paré, he was adored by his comrades in arms for his good nature, courage and humanity. His most interesting work is contained in the four volumes of his *Mémoires de Médecine Militaire* (1812–17) which contains the first account of 'trench foot.'" Garrison, History of Medicine.

A patient comes into the clinic with a crushed hand; because of the injury, sustained two weeks before, the skin over a large part of the dorsum of the metacarpus has become necrotic; the extensor tendons are exposed and partially necrosed. As each turn of the bandage is unwound he grimaces with pain. When the wound is exposed the students are asked in turn what should be done for the patient. One says, "Warm wet dressings to combat the infection"; another, "Dakin's solution"; another, "A skin graft when the infection is cleared up," etc. No one thinks of immobilizing the hand and relieving the constant pain which results from every movement of inflamed and injured tissues. The patient's facial expression, his apprehension at every touch, the position of the hand itself—falling

of its own weight and because of the injury of tendons and joint capsules into volar flexion—all cry for support in a position which relaxes the injured tissues; and yet the application of a splint is not considered.

Failure to recognize the importance of rest and relaxation of injured tissues is not limited to senior medical students. The house officer sees a patient with extensor tendons of ring and little fingers divided over the middle of the metacarpus. He sutures the tendons, closes the wound and bandages the hand. The idea of a simple splint to relieve tension on the sutured tendons (Fig. 1) does not occur to him. The orthopedic resident late in the day sees a nurse who has just sustained a glass cut over the dorsum of the metacarpophalangeal joint and who cannot extend the thumb. He realizes that the extensor pollicis longus has been divided, but bandages the hand and tells her to report to the chief in the morning. The idea of a splint to relax the muscle whose tendon has been divided does not occur to him. The attending surgeon operates upon a patient with radial nerve divided at the middle of the arm. He sutures the nerve and tells the house officer to close the wound. A splint to relax the paralyzed extensor muscles (Fig. 2) is forgotten and the patient is discharged from the hospital a week later with a healing wound but a hand limp in volar flexion. A general surgeon sees a patient with division of flexor tendons and median and ulnar nerves on the volar aspect of the wrist. He sutures the tendons and splints the part with wrist and fingers completely extended. If he glanced at his own hand at rest on the table or considered the position of the fingers when relaxed he would realize that complete extension of the fingers puts tension on the flexor tendons and muscles, and that if he immobilizes the fingers in such a position after suture of the flexor tendons either the sutures will give way or they will cut through the tendons and permit complete separation of the sutured ends.

The cases cited illustrate some of the important indications for the use of splints in the treatment of injuries and infections of the hand, but the purposeful use of splints involves still more than the well recognized principle of rest of injured tissues. Of equal importance with the care of tissues which have suffered a direct injury is the constant and prolonged relaxation of muscles whose nerve supply has been divided. The return of function, which one anticipates as regenerating nerve axons again grow downward into paralyzed muscles, becomes practically impossible of attainment if complete loss of elasticity and muscle tone has resulted from constant overstretching of paralyzed muscles by unopposed antagonists. A different but long recognized application of purposeful splinting is its employment so as to produce tension upon scar tissue for prolonged periods of time—particularly scar tissue that involves muscles, tendons and joint capsules. The subject of purposeful splinting can be presented to best advantage if the cases considered are grouped in accordance with the character of the injury and the anatomical structures chiefly involved.

1. INJURIES AND INFECTIONS OF THE SOFT PARTS —SKIN, SUBCUTANEOUS TISSUE, MUSCLES, JOINT CAPSULES

The relief from pain that follows immobilization of injured soft tissues is well exemplified by the rapid improvement that follows splinting of the hand and wrist following a simple sprain. A patient falls on his outstretched hand; or he wrenches the wrist in

Fig. 1. A simple aluminum splint to support little and ring fingers in extension and relax their extensor tendons. A crescentic piece is cut out on the radial side so as to eliminate pressure on the thenar eminence; the forearm portion is made concave so as to lie smoothly on the volar surface of the forearm.

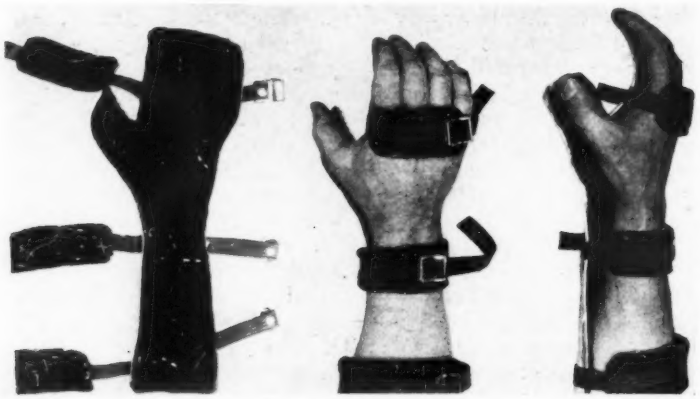
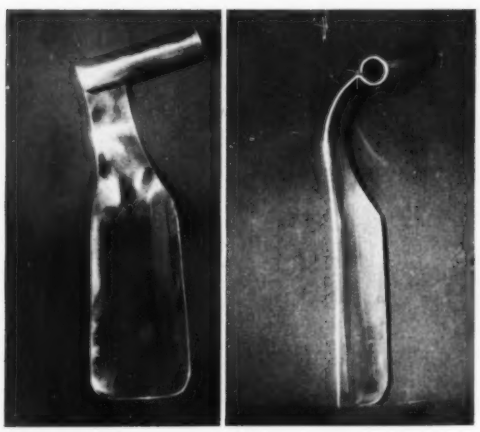


Fig. 2. Padded aluminum splint to relax the abductors and extensors of the thumb and the extensors of fingers and wrist. It can be easily removed for cleansing of the hand and application of physical therapy, and easily reapplied.

attempting to board a moving car; or he twists the fingers and thumb as he clutches at some support to keep himself from falling. The hand and wrist are painful and swollen, perhaps slightly discolored. Pressure over the ulnar side of the wrist-joint or over the metacarpophalangeal joint of the thumb causes exquisite pain. Certain movements exaggerate the pain. X-ray examination shows no evidence of chipped or of linear fractures. A sleeve of stockinet is drawn over the hand, and a plaster bandage is molded smoothly over volar surface of hand and forearm while the hand is held in the position of function—dorsiflexion at the wrist, semiflexion of thumb and fingers, abduction of thumb from hand, palm facing the patient. The free ends of the stockinet are turned back to cover the upper and lower edges of the plaster splint. A muslin bandage is applied firmly and smoothly over the hardening plaster, and almost before the dressing is completed the patient expresses the relief he has obtained from the immobilization and the smooth pressure of the bandage.

A similar splint or one of light aluminum which immobilizes the hand with crushed fingers, or with lacerated wounds, or with surface seared by a flame or by boiling water immedi-



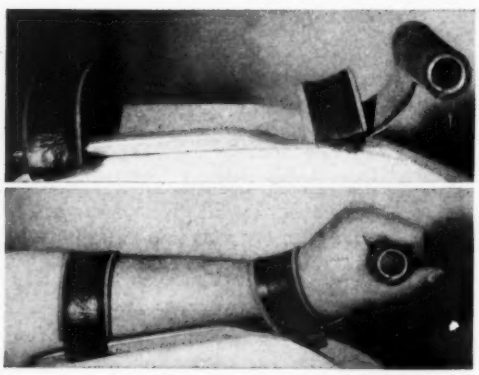


Fig. 3. Splint for maintaining the hand in the position of function.

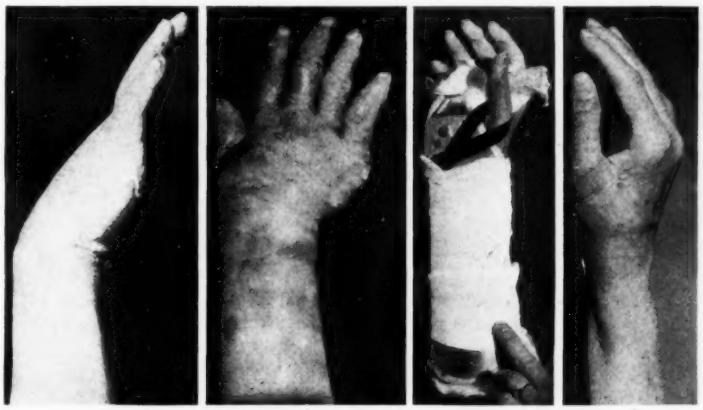


Fig. 4. Result of physical therapy combined with splinting of the hand in the position of function in a case of neglected infection involving the radial and ulnar bursæ. a, b, Appearance and position of hand at beginning of treatment. c, Metal splint, similar in principle to that illustrated in Figure 3, with elastic band to abduct and rotate thumb. d, Result at time wound discharge had ceased.

ately adds to the patient's comfort and perhaps permits him the first relief from pain.

If the inflammatory reaction associated with a spreading infection is added to the hemorrhage and tearing of tissue that result from injury, rest is even more important; and if it can be provided with the affected part in the position of function (Figs. 3, 8), the ultimate result will be most satisfactory (Fig. 4).

If contractures have developed as a result of neglected injuries or long continued infections, much can be accomplished by the use of splints which bring constant tension to bear upon scar tissue, whether it involves the superficial tissues, the muscles, the tendons, or the joint capsules. The principle involved has long been accepted, and the use of tension in overcoming contractures, particularly of the von Volkmann type, advocated long ago by Claude Martin and his pupils in France and by Sir Robert Jones in England, has been the most important factor in the successful treat-

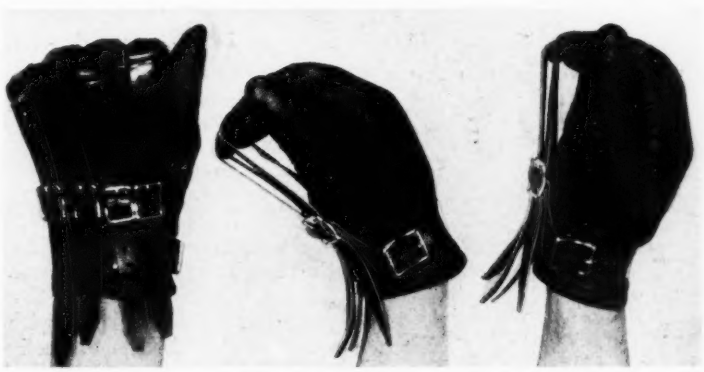


Fig. 5. Glove fitted with buckles and straps to permit application of tension to fingers stiff in extension. Tension can also be exerted upon the thumb if a buckle for the thumb strap is attached to the ulnar side of the glove at the level of the web.

Fig. 6. Complete restoration of function of thumb resulting from simple splinting of thumb in abduction and extension for 4 weeks following division of extensor pollicis longus.

ment of this condition. Purposeful splinting in the treatment of contractures involves the use of splints which permit the application of steady tension for prolonged periods of time, which do not produce excessive pain, and which can be easily adjusted and easily applied and removed so as to permit active use of the hand and the application of physical therapy in conjunction with the use of the splint. In cases in which the small joints of the hand have become stiff in extension the use of a glove fitted with straps and buckles, which permit the fingers to be drawn into a flexed position (Fig. 5), often is helpful.

2. DIVISION OF MUSCLES AND TENDONS

The retraction toward its origin, and to a lesser extent toward its insertion, that takes place the moment a muscle belly or its tendon is divided, is a well recognized fact. Released from their normal tension muscle fibers immediately contract to a position of rest. If the muscle or tendon is completely divided, and if the tendon glides in an individual sheath, as does the flexor pollicis longus for example, no amount of restraint or fixation of the affected part will prevent separation of the two ends or permit satisfactory healing without approximation by surgical operation. If, however, the muscle or tendon is not completely divided; or if its retraction is checked by bands or fibers of attachment to adjacent tendons, such as unite adjacent extensor tendons on the dorsum of the metacarpus; or if it is fixed to some extent by areolar tissue, such as surrounds the extensor pollicis longus on the dorsum of the thumb, immobilization of the part in a position that brings the insertion of the muscle as close as possible to its origin offers a reasonable chance that operation may be avoided. Such immobilization should be carried out in every case in which immediate operative treatment is contra-indicated because of the conditions under which the wound has been sustained or because the most favorable time for operative care has passed before the patient is seen by the surgeon. Four times in recent years we have seen restoration of function of the completely divided extensor pollicis longus follow immobilization of the thumb in the completely extended position, with the help of a splint applied 24 hours after injury and kept in place for a period of four weeks (Fig. 6).

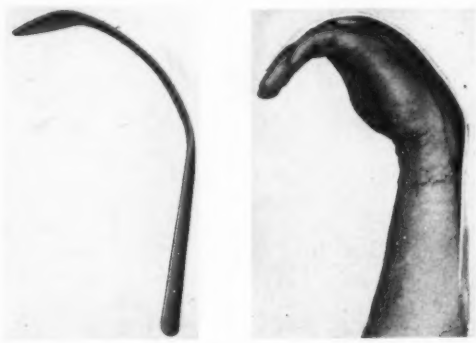


Fig. 7. Dorsal splint for securing relaxation of flexor tendons of fingers. The maximum flexion should be at wrist and metacarpophalangeal joints.

Satisfactory, though not completely successful, results have been obtained in a num-

Fig. 8. Splint for supporting fingers in extension and thumb in extension and abduction after suture of extensor tendons or injury of radial nerve. By bending the distal end of the splint slightly to permit semiflexion of the fingers this splint serves equally well for maintaining the hand in the position of function.

ber of cases in which open wounds of the dorsum of the hand have been followed by infection and sloughing of covering tissue and extensor tendons. By splinting the hand in dorsal flexion at the wrist and almost complete extension at metacarpophalangeal and interphalangeal joints, and by treating the open wound with cleanly surgical care, and in some cases with a skin graft of intermediate thickness, healing has been obtained in such cases and a bridge of scar tissue formed between the ends of widely separated tendons, which acted as a substitute for the extensor tendons and permitted the fingers and hand to be brought to a straight line when healing was complete. Although the fingers could not be maintained in complete extension when the hand was held in hyperextension at the wrist, the functional results were satisfactory and the necessity for technically difficult operative procedures avoided.[1]

If tendons have been sutured the part should be immobilized in such a position that minimum tension is put upon the suture line. Otherwise one of several unfavorable results occurs: the suture material cuts through the tendon ends and fails to hold them in approximation; or the suture material gives way completely; or, at best, the fibroblastic and fibrous tissue which forms to unite the tendon ends is stretched to such a degree that the tendon is lengthened and the maximum contraction of the muscle belly is not sufficient to take up the slack.

If flexor tendons of thumb or fingers have been sutured relaxation is best obtained by flexion at wrist and metacarpophalangeal joints (Fig. 7). The fingers should not be sharply flexed at the interphalangeal joints. Flexing the fingers about a roller bandage in the palm after suture of their flexor tendons frequently results in fixation of the tendons within their digital sheaths and a contracture exceedingly difficult to overcome. After suture of extensor tendons relaxation of fingers or thumb can be obtained by dorsal flexion at the wrist and complete extension at metacarpophalangeal and proximal interphalangeal joints (Fig. 8).

3. NERVE INJURY

Sir Robert Jones in a lecture to a group of American medical officers once stated his be-

[1] If there has been loss of both covering tissue and tendons on the dorsum of the hand and healing takes place by scar tissue formation, one cannot hope to unite the separated tendons or to replace the destroyed tendons with grafts without first securing a covering of normal skin and subcutaneous tissue to replace the destroyed covering tissue. The attempt to make an incision in scar tissue, dissect it from its bed to expose injured tendons, and then replace it and suture the incision will end in extensive sloughing and loss of tissue because of the low vitality of the scar tissue covering.

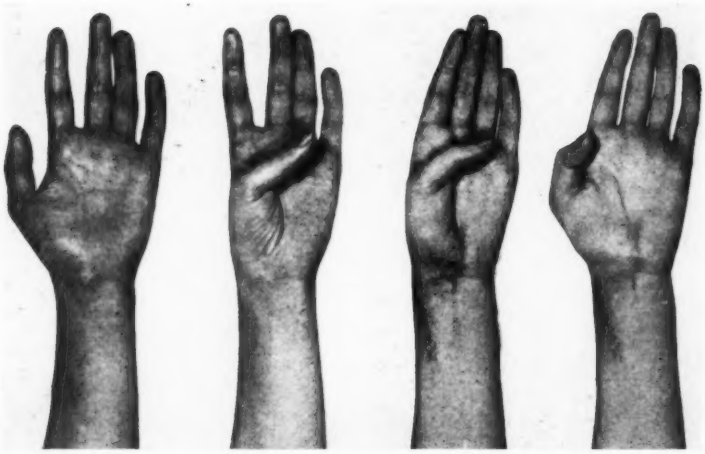


Fig. 9. Typical appearance of hand following division of median nerve and flexor pollicis longus; the atrophy of thenar eminence and inability to rotate the thumb to oppose the fingers are characteristic of median nerve injury. a, b, Before operation. c, d, Degree of flexion at interphalangeal joint of thumb possible 3 weeks after operation.

lief that if the hand and fingers were allowed to fall into complete flexion only once after a division of the radial nerve, an irreparable injury of the extensor muscles resulted. If a single overstretching of paralyzed muscle fibers causes irreparable injury it is obvious how serious must be the effect of permitting paralyzed muscles to be continually overstretched by powerful and unopposed antagonists. The typical deformity of the hand that results from the paralysis of the small muscles of the hand following injury or division of median and ulnar nerves is recognized by every medical student. Curiously enough, though we take great pains to teach the student the meaning of the "ape hand," the flat and wasted thenar eminence (Fig. 9), the hyperextension at metacarpophalangeal joints, rarely is it emphasized that with adhesive strapping or a leather wristlet with suitable attachment it is possible to rotate the thumb to face the fingers (Fig. 10); or that with a simple and light splint the fingers can be supported in slight flexion at the metacarpophalangeal joints (Fig. 11) and the thumb adducted toward the hand, and so paralyzed thenar muscles, lumbrical and interosseous muscles and adductors of the thumb can be protected from the harmful effects of continued overstretching.

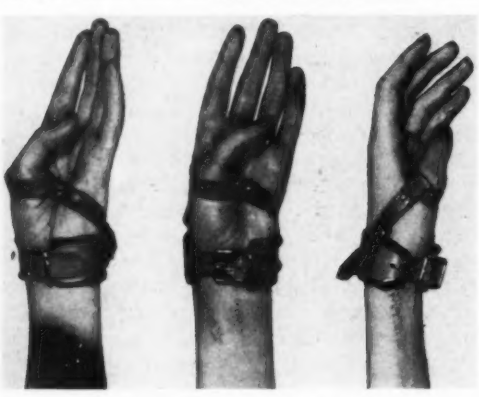


Fig. 10. Simple strap apparatus for rotating thumb so as to face fingers; the strap attached to the loop around the thumb is buckled to the wrist strap on the dorsum of the wrist.

If the maximum value of such treatment is to be obtained for the patient it must be persisted in until functional restoration takes place. Sir Robert Jones expressed it tersely, "The most skilful operation performed on the most suitable case will prove a fiasco unless the affected muscles are continually kept relaxed until recovery takes place." In other

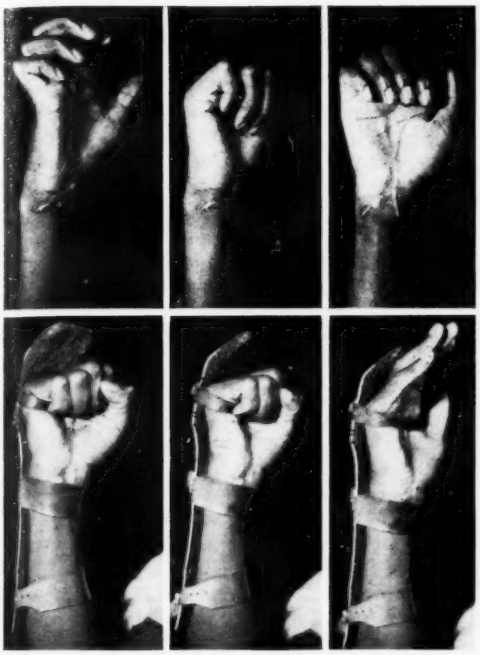


Fig. 11. Splint for supporting fingers in semiflexion at metacarpophalangeal joints after suture of median and ulnar nerves. Strap shown in Figure 10 is attached to ulnar side of splint. Above, Appearance of hand 3 months after injury and repair of divided median and ulnar nerves and all flexor tendons. On attempting to straighten the fingers they fall into hyperextension at metacarpophalangeal joints because of lumbrical and interosseous paralysis. Below, Result 14 months after injury. Splint shown was worn constantly for 11 months to prevent overstretching of paralyzed muscles.

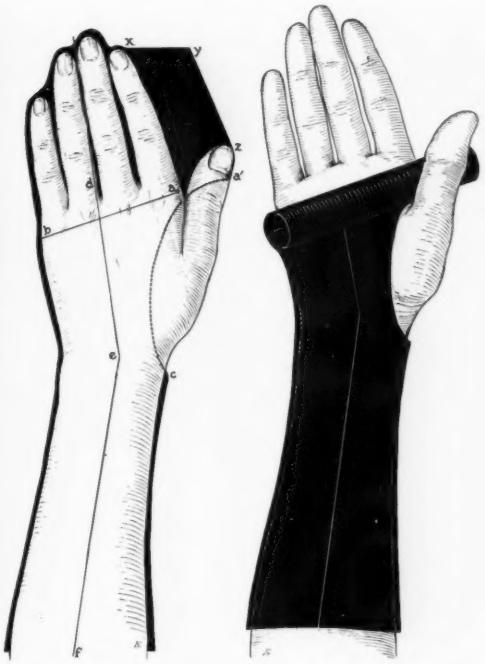


Fig. 12. Pattern (in black) for making a simple splint to support hand in position of function. When at rest the longitudinal axis of the hand, *de*, makes a slight angle with the axis of the forearm, *ef*. The line of the metacarpophalangeal joints, *ba*, is not quite transverse to the long axis of the hand, and makes a still greater angle with the long axis of the forearm.

When the splint is cut along the line *a'c*, and the flat sheet distal to the line *ba* rolled into a small cylinder the splint lies smoothly on hand and forearm without pressure on thenar area. A few blows of the hammer are needed to gutter the part over the forearm and a slight bend in dorsal flexion at the wrist.

words, after suture of median and ulnar nerves just above the wrist the fingers must be supported in slight flexion at the metacarpophalangeal joints and the thumb in rotation and partial adduction during the period of from 9 to 15 months that is required for the slow downward growth of nerve axons. One patient recently under observation, a 12 year old boy operated upon a few hours after injury by Dr. Russell Bothe, then surgical resident at the Cook County Hospital, wore out the felt covering and leather straps on his splint three times during the course of a year, but the result obtained justified the trouble and inconvenience involved in the treatment (Fig. 11).

If the radial nerve is divided above the origin of its motor branches the paralyzed extensors and abductors must be supported in the relaxed position. Such a position involves abduction as well as extension of the thumb (Fig. 8). Simply to support the fingers and thumb on a flat splint dorsiflexed at the wrist is to ignore the importance of abduction in the function of the thumb.

THE PREPARATION OF SPLINTS

Since the surgeon may be called upon at any moment to provide a splint for any one of many indications and for any size of right or

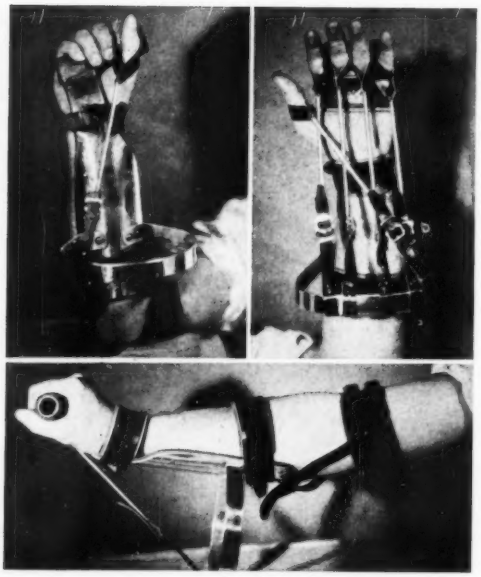


Fig. 13. The same splint as in Figure 3 with cross bar, straps, buckles, springs, and loops for the production of elastic tension on fingers and thumb. (In a, left, above, and c, below, only one strap, buckle, spring and loop are shown so as to make the illustration clearer.)

left hand he must have available adaptable material and means of fashioning it to the required end.

For simple immobilization for a relatively brief period of an injured hand or forearm without an open wound nothing is more satisfactory than plaster-of-paris smoothly molded over closely fitting stockinet on dorsal or volar surface of the injured extremity. Thumb or fingers can be included if necessary, or the splint stop short at any desired level to permit movement at certain joints.

For most other purposes—for patients with open wounds, for tension splints, for splints requiring frequent removal, and particularly for splints intended for use for long periods of time—aluminum has been found particularly useful and adaptable. Sheet aluminum .064 inches in thickness, designated by the manufacturers No. 2 S½H, can be easily cut to the desired size with ordinary "tin snips." It is sufficiently rigid to maintain any desired shape, and still light enough not to be cumbersome. With a few simple tools which can be kept in a drawer in the splint room—snips, a hammer, a jig saw to cut finger pieces, bending irons, file and sandpaper to smooth rough edges, a small drill to bore holes, rivets with which to attach a thumb piece—and with a vise in which the splint can be firmly held as it is fashioned and smoothed off, splints for most purposes can be promptly and easily prepared. For hinged splints and tension splints with slotted finger pieces we depend upon the splint maker who

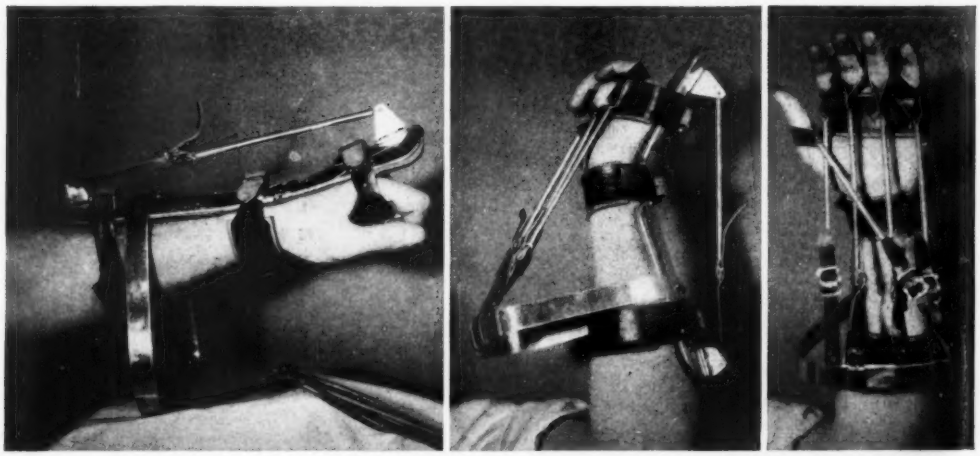


Fig. 14. A splint designed to produce the same effect as that in Figure 13, but to be applied to the dorsum of the hand.

has more elaborate tools and metal cutting instruments at his command.

A few standard patterns serve as a basis for the great majority of splints required in ordinary surgical practice.

1. Volar cock-up splint. This splint (Fig. 3) is designed primarily to support the hand in the position of function: dorsiflexion at the wrist, semiflexion at metacarpophalangeal joints and thumb abducted from the hand. Support of the hand in such a position during the long period of convalescence from a severe infection or an extensive burn greatly simplifies the problem of restoration of function when healing is complete. If used in the presence of acute infection the splint can be sterilized and incorporated in a large warm wet dressing. At a later stage it can be padded with soft rubber which can be easily cleansed and autoclaved if necessary. If used when little or no wound discharge is present it can be covered with felt and provided with straps and buckles to facilitate application and removal.

In making a pattern for the splint the normal hand of the patient is laid palm downward on a sheet of white paper and a tracing made of the hand and forearm (Fig. 12). Three points are marked on the tracing: *a*, the radial border of the hand at the level of the second metacarpophalangeal joint; *b*, the ulnar border of the hand at the level of the fifth metacarpophalangeal joint; *c*, the radial border of the forearm at the level of the radial styloid. An outer line, *xyz*, is added to give a rectangular shape to the distal end of the pattern. A crescentic section is cut from the pattern along the line *a'c* so as to eliminate pressure upon the thenar eminence. The rectangular portion of the splint distal to the line *aab* is rolled into a cylinder of small diameter in such a way that the long axis of the cylinder lies exactly parallel with the line *ab*. The cylinder should rest easily between thumb and fingers and permit

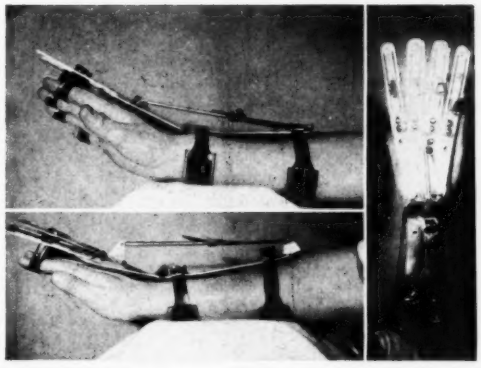


Fig. 16. A splint to produce extension of semiflexed fingers and wrist with the aid of elastic tension.

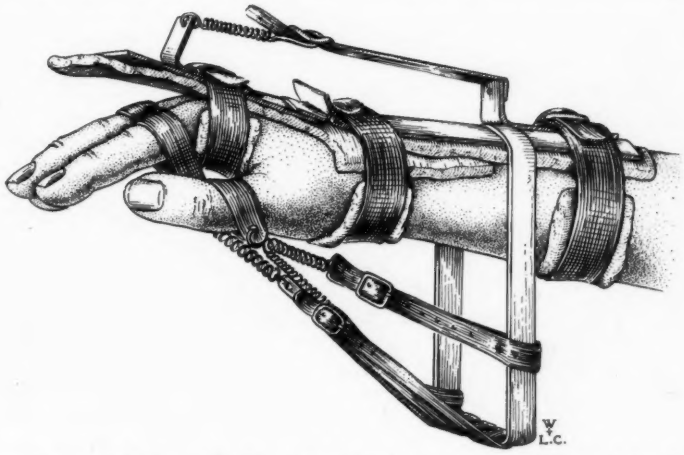


Fig. 15. Splint for application of elastic tension to semiflexed fingers and thumb lying alongside hand.

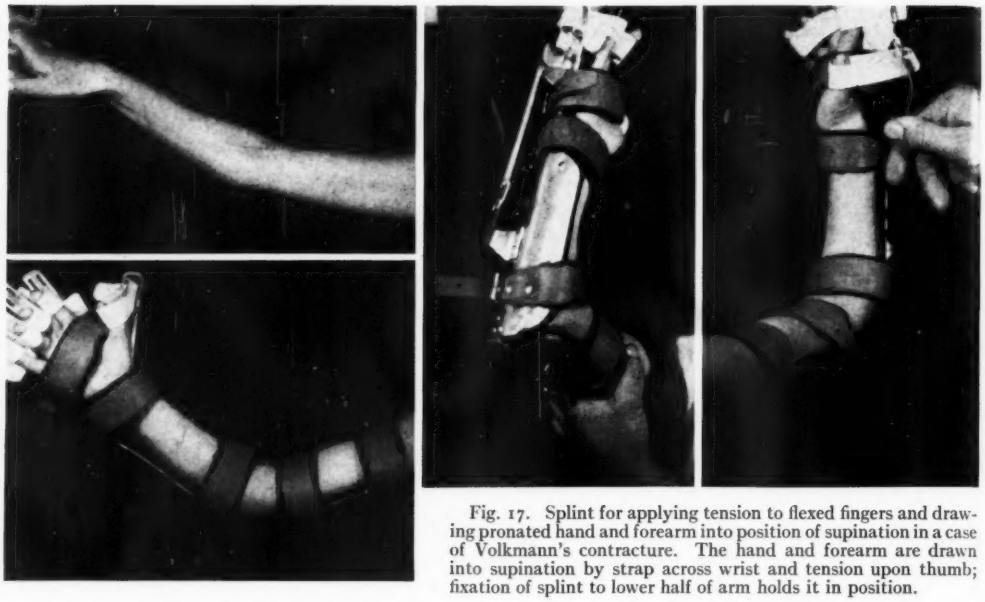


Fig. 17. Splint for applying tension to flexed fingers and drawing pronated hand and forearm into position of supination in a case of Volkmann's contracture. The hand and forearm are drawn into supination by strap across wrist and tension upon thumb; fixation of splint to lower half of arm holds it in position.

flexion of the fingers at the metacarpophalangeal joints. Its long axis lies almost transverse to the vertical axis of the hand piece, *de;* and the latter forms a slight angle with the vertical axis of the forearm piece, *ef*. When the splint is guttered so as to lie smoothly on the forearm, and bent slightly at the wrist joint so as to provide dorsal flexion at the wrist joint, it should support the hand comfortably in the position of function (Fig. 3, d).

2. Splint for extension of fingers and thumb. If it is desired to hold the fingers and thumb in extension, for example, after suture of extensor tendon or injury of radial nerve, the splint is prepared from a pattern similarly made but the added portion, *axyz*, is omitted; and a thumb piece is added by riveting to the splint at the proper angle a single strip of aluminum, 1 inch wide and turned in such a way that the thumb rests easily upon it (Fig. 8).

3. Splint to apply tension upon fingers at metacarpophalangeal or interphalangeal joints. If it is desired to put tension upon stiff metacarpophalangeal or interphalangeal joints while the hand is held in dorsal flexion at the wrist-joint, a bridge or arch of aluminum can be riveted to the splint (Fig. 13) and from it tension applied to each digit. A loop to slip over each finger, and united to a corresponding loop on the bridge with a tension spring, a buckle and strap constitute a device easy to apply and remove, and easy to adjust to any degree of tension.

4. Dorsal splint for application of tension upon fingers. If because of volar scars or open wounds it is found undesirable to place the splint on the volar surface of the forearm, a similar effect can be obtained by making the splint in two pieces, one for forearm and one for hand, and uniting them with a hinge at the wrist joint. Dorsal flexion of the desired degree can be obtained by a stout spring, strap and buckle running from the distal end of the hand piece to the forearm piece (Figs. 14, 15). The pull on individual digits can be obtained by adding a bridge or arch, and straps and springs for individual digits just as with the volar cock-up splint.

5. Splint for application of tension on flexed fingers. The hinged dorsal splint can be used to advantage in cases of flexion contracture of the fingers, whether the contracture is of the typical Volkmann type or whether it has followed infection or injury other than the typi-

cal injury about the elbow joint which leads to Volkmann's contracture. If the contracture is not too marked and the fingers can be partially extended a splint such as that illustrated in Figure 17 is useful. The thumb piece permits the application of tension to the thumb; the direction of the line of tension can be changed as desired; usually the thumb needs to be abducted from the hand so as to increase the span between thumb and index finger.

If the fingers are sharply flexed into the palm a splint which permits a pull directly distalward instead of dorsalward is required. Such a pull can be obtained with loops, springs and buckles attached to elongated finger pieces (Fig. 17) or by lengthening the slotted finger pieces shown in Figures 16 and 17 and bending them at a right angle near their distal ends.

Since this type of splint is usually required for advanced cases of Volkmann's contracture two other features are usually added to it: a thumb piece, extending outward from the splint opposite the base of the thumb, and a short arm piece, attached to the forearm piece by a hinge at the elbow, which serves both to keep the splint from being displaced distalward along the forearm, and so neutralizing the tension, and as a fulcrum from which tension in the direction of outward rotation of the forearm can be obtained (Fig. 17).

The latter is important in those cases in which the hand with sharply flexed fingers is constantly held in pronation. Unless it can be drawn into supination at the same time that the fingers are drawn into extension the result will not be satisfactory. With the splint held in a fixed position with the aid of the arm piece the hand and forearm are drawn toward the position of supination with the help of a broad strap across the wrist joint and the outward pull upon the semiflexed thumb.

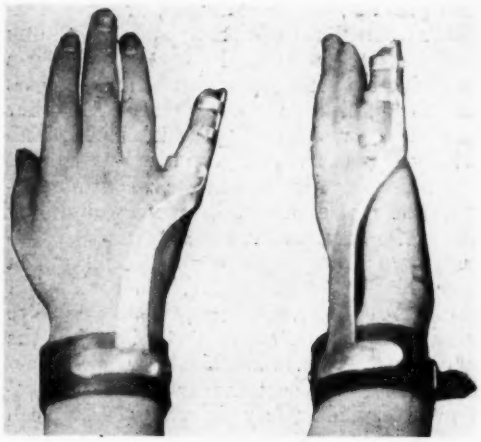


Fig. 18. Modification of Lewin's baseball finger splint for supporting a single finger in extension after suture of extensor tendons.

Other modifications of these splints will suggest themselves to anyone who is constantly confronted with the treatment of injuries of the hand. A single extension piece, for example, can be added to the volar cock-up splint and permit application of tension to a single digit while the others are supported in the position of function. For a fracture of a proxi-

Fig. 19. Splint for applying tension upon a proximal interphalangeal joint left immobile in flexion after division of the extensor tendon. The proximal phalanx is drawn toward the splint by a circle of garter elastic.

mal phalanx, of a metacarpal, or for a Bennett's fracture of the metacarpal of the thumb such a splint is helpful. To support the fingers in abduction after separation of fused fingers and the application of a free graft a flat splint can be prepared with individual finger pieces widely separated. Such a splint gives support and immobilization and at the same time permits the application of sponge pressure over the grafts between the separated fingers. To support a single finger in complete extension a modification of Lewin's baseball finger splint is useful (Fig. 18). To bring elastic tension to bear upon an interphalangeal joint after the finger has been left immobile in flexion following division of the extensor tendon a modification of Bunnell's safety pin splint (Fig. 19) can be used to advantage.

It is hardly necessary to add that much effort and ingenuity have been expended by many men to devise satisfactory splints for immobilizing and protecting the injured hand. The cockup splint of Sir Robert Jones for supporting the hand in dorsiflexion at the wrist is known to every surgeon. The "baseball finger" splint of Lewin and the "safety pin" splint of Bunnell for producing extension at the proximal interphalangeal joint have been mentioned. William E. Browne's ingenious and adaptable splint can be utilized for many of the conditions referred to in the preceding pages.

SUMMARY

Purposeful splinting following injuries and infections of the hand involves at least three important principles: (1) securing rest for injured and inflamed tissues, whether soft tissues, tendons, muscles, joint capsules or bones; (2) securing relaxation of muscles whose tendons have been divided or whose nerve supply has been injured; (3) bringing constant and prolonged tension to bear upon scar tissue whose gradual contraction interferes with the function of the hand. The studied application of these principles can aid very definitely in bringing about restoration of function after injury and infection have taken place.

REFERENCES TO THE LIFE OF THOMAS

1. AITKEN, D. MCCRAE. Hugh Owen Thomas; His Principles and Practice. London: Oxford University Press, 1935.
2. KEITH, ARTHUR. Menders of the Maimed. Chap. 3. London: Henry Frowde, 1919.
3. MCMURRAY, T. P. The life of Hugh Owen Thomas. Liverpool M.-Chir. J., 1935, 43: 3-41.
4. THOMAS, H. O. Diseases of the Hip, Knee, and Ankle Joints; with Their Deformities, Treated by a New and Efficient Method. 2d ed. Liverpool: T. Dobb & Co., 1876.
5. Idem. On past and present treatment of intestinal obstruction. Liverpool and Manchester M. & S. Rep., 1877, Liverp., 1878, 1–58.
6. Idem. On the treatment of fractures of the lower jaw. Lancet, Lond., 1867, 1: 79.
7. WATSON, FREDERICK. Hugh Owen Thomas; a Personal Study. London: Oxford University Press, 1934.
8. Idem. The Life of Sir Robert Jones. Baltimore: William Wood & Co., 1935.

REFERENCES TO THE USE OF SPLINTS

1. BROWNE, W. E. The necessity for use of splints at certain stages in the treatment of infections of the hand, with a demonstration of some of the newer types. New England J. Med., 1936, 215: 743–748.
2. BUNNELL, STERLING. Reconstructive surgery of the hand. Surg., Gynec. & Obst., 1924, 39: 259–274.
3. JONES, SIR ROBERT. Notes on military orthopaedics. II. On suture of nerves, and alternative methods of treatment by transplantation of tendon. Brit. M. J., 1916, 1: 641.
4. Idem. An address on Volkmann's ischaemic contracture with special reference to treatment. Brit. M. J., 1928, 2: 639–642.
5. LEWIN, PHILIP. A simple splint for baseball finger. J. Am. M. Ass., 1925, 85: 1059.
6. MARTIN, CLAUDE. Bull. de la Soc. de chir. de Lyon, 1902–03.

FLUID BALANCE IN THE PUERPERIUM

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THE more we add details to the sum of knowledge about any common disease when it occurs in patients who are in, or immediately past, the period of gestation, the more it appears that pregnancy distorts the picture from that presented in the non-pregnant. This conviction and noted instances of undoubted polyuria after delivery have supplied for me the impetus to investigate fluid balance in the puerperium as a distinct entity. I am conscious of the fact that the methods employed in obtaining these data fall far short of scientific requirements in completeness; a complete study is more fittingly performed in a well equipped laboratory and then on comparatively few patients. It may not be wasted effort if, from a more gross demonstration of the essential findings in a larger group of cases, intensive study of a smaller group may be stimulated and carried out under proper laboratory conditions.

In the beginning I wish to present a group of hitherto unassociated observations which indicate: first, that the pregnant woman fails to eliminate fluids as adequately as does the non-pregnant woman; and second, that the storage of fluids in the blood stream and tissues of the body in the course of a normal pregnancy may, and probably does, without production of anasarca, take place elsewhere in the body besides in the obvious place for fluid increase, that is, in the products of pregnancy.

These observations fall under three headings:

1. Evidence of increased fluid content of the blood.

2. Evidence of retardation in the mechanism of conducting secreted urine away from the secreting unit, the renal cortex.

3. Functional tests, in so far as they have yet been applied to pregnant women, paradoxically indicate decreased functional activity without evidence of storage of waste products of metabolism in the blood stream.

Whatever may be the etiology of the storage of fluids in pregnancy, if it exists, the wisdom of such provision is obvious. At delivery, there occurs a sudden and excessive drain upon body fluids which is immediately followed by further encroachments during the immediate postpartum period. Within a very short time, the patient eliminates from her body the products of her pregnancy, accompanied by the loss of blood and excessive radiated fluids attendant upon her exertions. The fluid losses at delivery may be enumerated as amniotic fluid, fluid content of the baby, blood and fluid content of the placenta, blood loss of the mother, and excessive lung and skin radiation. The ensuing postdelivery losses within the 14 day convalescence covered in this study are lochia, some of which is included inadvertently in the urine and the remainder caught in pads, and mammary gland secretions. Loss of fluid through these two factors, while not measured or allowed to enter into this problem, are considerable. The "milk department" of the Bostom Lying-In Hospital states that during the first postpartum days, average secretion from the mammary glands is 15 ounces but that it soon rises to 32 to 40 ounces with peak output for individual patients as high as 64 ounces each 24 hour period.

In the studies here recorded, no consideration is given to the fluid loss at delivery or to the lochial and milk loss during the puerperium. The record comprises only the liquid food and water intake to determine the intake curve, and the urinary excretion with whatever lochia may accidently be included, to determine the output curve. The period covered begins immediately upon delivery but does not include urine removed by catheter during delivery and continues to the end of 14 days, at which time patients are normally discharged from the hospital. Wherever unavoidable loss of urine has been encountered,

From the Urological Clinic of the Lying-in Hospital.
The B. A. Thomas Lecture at Philadelphia January 24, 1938.

Fig. 1. Roentgenogram of patient; aged 24 years. Complaint: fatigue, pain in left hip. Excretion periods 5, 15, 25, and 40 minutes. The accuracy of calyceal delineation is best on left at 5 minutes, on right at 15 minutes. Beginning emptying on both sides at 25 minutes.

the graphs are so marked. Credit should here be given to the nurses of the Boston Lying-In Hospital, who, under the direction of Miss Garran, showed both painstaking attention to detail and ingenuity in obtaining accurate records.

One may more readily accept the obvious premise that there is abundant need for excess fluid in the body of a woman who is about to undergo delivery, than prove its presence. A few women, because of extensive edema, can safely be assumed to have excess fluid. These cases are not the rule, however, and most pregnant women cannot be considered edematous. While one may assume that uterine pressure causes vulval and leg swelling, edema is not proved to show predilection for the primiparous patients in whom inelastic abdominal walls form a tight fitting uterus. And in cases in which small amounts of local edema occur, as seems to be the case in about three-fourths of pregnant women, it is almost as apt to be in the abdominal wall above the point of pressure against the great vessels of the pelvis as in the lower extremities. There is, however, a peculiar softness to the tissues in pregnancy that imply fluid excess although demonstrable edema may be entirely absent. In the Boston Lying-In Hospital an energetic cardiac clinic promptly labels circulatory deficiencies. In the patients studied, the cardiac cases are noted and their classification given.

During the period covered in this study no attempt was made to segregate types of cases. It seemed wiser that all types should be included irrespective of their clinical complications in order that a cross section of obstetrical cases might be obtained. The result was that the whole hospital population was put on

Fig. 2. Roentgenogram of primipara; unit history No. 23,052. Complaint: transitory albuminuria. Study case; 2½ months pregnant; uninfected. Excretion periods 5, 15, and 30 minutes. Best plate 15 minutes.

measure and record charts. For this reason there are only small numbers of each of the groups except the normal deliveries. In most instances the number in each subdivision is too small to justify deductions from them except in comparison with the whole group.

In this communication the probability of excess fluid in pregnant women is established by deduction from present known facts concerning pregnancy. The study demonstrates that in 55 cases, with the exception of 5 in which, owing to rapid increase of fluid intake because of infection, output lagged behind intake beyond the 14 day period, there was but one instance in which there was not a readjustment of fluid balance during the puerperium in which the output of urine exceeded the intake of fluid by a total of from 3 ounces to 214 ounces extending over a period of from 1 to 8 days. I shall therefore assume that this phenomenon implies an excess of body fluids which may be capable of withstanding the fluid losses of delivery, lochial loss during the postpartum, and lactation during the 14 day study period; and still show the need for readjustment, if the normal situation of intake exceeding output by the amount of the normal body fluid losses through respiration, skin radiation, fecal fluid content, etc., is to be reapproached.

In estimation of the etiology of fluid storage in pregnant women, one turns immediately to the well known renal dilatations of pregnancy which are now recognized as being almost universally present. They undoubtedly vary both in time of appearance and in extent. This may be so because of variable mechanical pressure factors in which the uterus obstructs the ureters to varying degrees. Pressure alone now seems inadequate to explain pelvic and ureteral changes in pregnancy. The modified endocrine state in pregnancy must be added to pressure to explain the renal changes in the gravid state. The degree of endocrine variation may not be any more constant than pressure mechanics either in one individual at various periods or among individuals. I know of no data from which I can assume that the effect of the pregnancy hormonal state is to produce impaired secretive action in the renal substance. In fact, intravenous urography indicates prompt secretion of the media into the calyces. I believe that until more data are collected from studies of endocrine effect on organs, we are justified in assuming that muscular atony of

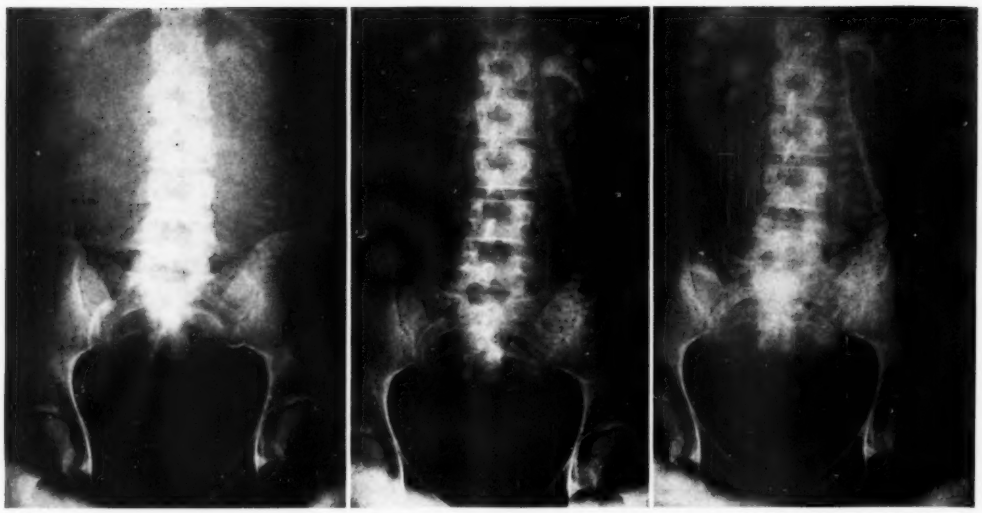

Fig. 3. Roentgenogram of primipara; unit history No. 18,192. Complaint: acidosis and vomiting. Pyelography at 6 months; uninfected. Excretion periods 5, 15, and 45 minutes. Best plate 45 minutes. Dye appears in calyces of both kidneys at 5 minutes. Dense concentration of dye in calyx on right and in calyx, pelvis, and ureter on left at 15 minutes. At 45 minutes right ureter only dimly outlined, left ureter excellently outlined.

the conduction apparatus is the factor concerned. Failure to remove secreted fluids from the secreting unit may impair fluid clearance from the kidneys, as prostatic obstruction of the bladder seems to be followed by polyuria when constant drainage is established.

I am prepared to accept a double etiology for these renal changes which take place in pregnant women. They seem to me to be capable of playing the major rôle among significant factors favoring storage of fluids during pregnancy. They are first, relaxation of the musculature of calyces, pelvis, and ureters as a manifestation of a changed endocrine state in pregnant women, and second, pressure of the abdominal wall as well as gravity, which tends to force the inverted cone shaped uterus into the inelastic bony pelvis, across the brim of which the ureters pass in an exposed position, the right one more so than the left. It is not now possible to dissociate these two factors in importance in estimating roentgenographic appearances and physiological behavior of the changed renal tree. The evidence now available seems to indicate that endocrine changes are at least of equal importance with pressure in producing this phenomenon. Both in pregnant women and in pregnant quadrupeds, when the pressure factor can be almost, if not completely, eliminated, evidence has been produced in the several investigations which I shall mention, to indicate that atonic relaxation of the renal tree begins almost immediately in pregnancy, and that it antedates the presence of sufficient uterine enlargement to produce pressure against the ureters.

I do not doubt that pressure accentuates pelvic and ureteral changes in women over quadrupeds. It also is the only acceptable explanation to date of unequal degree modification of the right renal tree over the left in pregnant women. Renal changes seem to begin quite early in the latter and to become progressive in degree throughout the greater part of pregnancy. Pressure changes appear to be mechanically possible only from shortly before mid-pregnancy on to term; yet in most of the several researches noted, there appears to be partial relief from renal embarrassment in the latter weeks of pregnancy without improvement in the mechanical set up which

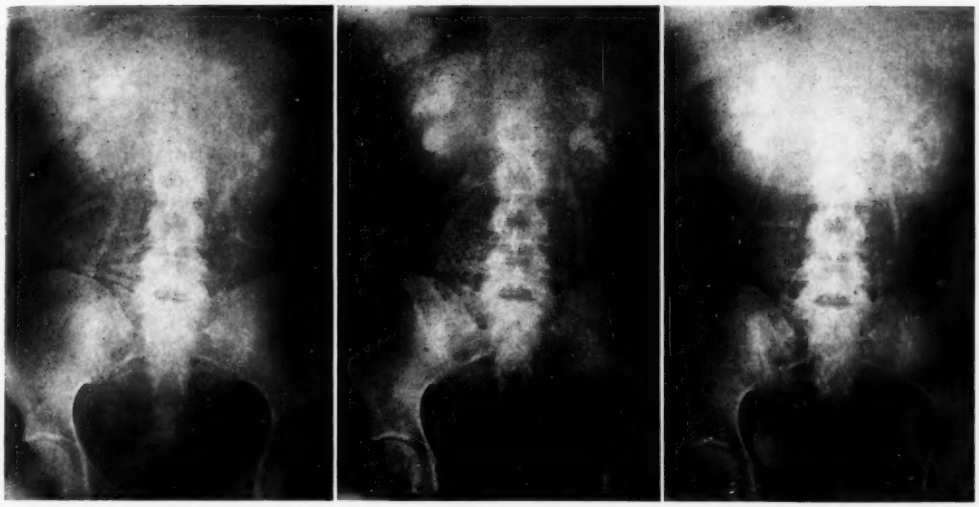

Fig. 4. Roentgenogram of primipara; unit history No. 23,234. Pyelography at 6 months. Complaint: right renal distress. Excretion periods 5, 15, and 40 minutes. Only calyces fill at 5 minutes. At 15 minutes right calyx dense, left pelvis and ureter dimly outlined. At 40 minutes, right ureter not yet filled, left pelvis and ureter clearly outlined.

makes pressure against the ureters possible. Those changes in the behavior of the renal tree in regard to secretion and clearance of urine, which antedate a mechanical set up that can conceivably bring pressure to bear against the ureters, must be attributed to some other factor.

Rowntree, in a summation of known facts regarding water balance (1922), states that the endocrine system unquestionably plays a part in the control of this balance and that polyuria follows extirpation of the posterior lobe of the pituitary body. Further work in succeeding years has indicated a fluid balance disturbance during the catamenia and that the pituitary body participates in the changed endocrine state of pregnancy and the puerperium.

I have assembled 7 observations, most of them from dissociated sources, all of which seem to me to be trustworthy. In these there is a striking uniformity in findings. The changes which are discussed appear uniformly to assert themselves in the first trimester of pregnancy, reach a peak of effectiveness in mid-pregnancy, and most of them show an upward trend beginning about the eighth month of pregnancy. These observations collectively, as well as each in its own right, seem to indicate the probability that fluids are stored in the body of the pregnant woman in the course of her 9 months' gestation.

The first of these citations has to do with dilution anemia (Minot, Straus, Castle, Rowland, Wills, Talpade, 2). Briefly stated, the normal blood picture of the non-pregnant changes during the first 4 months from a hemoglobin reading of 80 to 85+ per cent and a red cell count of 4,000,000 to 4,500,000, to a hemoglobin reading of 60 to 70 per cent and a red cell count of 3,000,000 to 3,500,000, with definite evidence of improvement in both hemoglobin and cell count beginning at the eighth month of gestation. This variation is due entirely to increase in plasma. The cells are normal in number and character. The condition is not improved by liver, iron, or other therapeutic measures. In other words, there is a normal cell constitution but an excess of the fluid content of the blood.

The second item of evidence is provided by animal experimentation. Rossi has recorded his observations on the effect of preg-

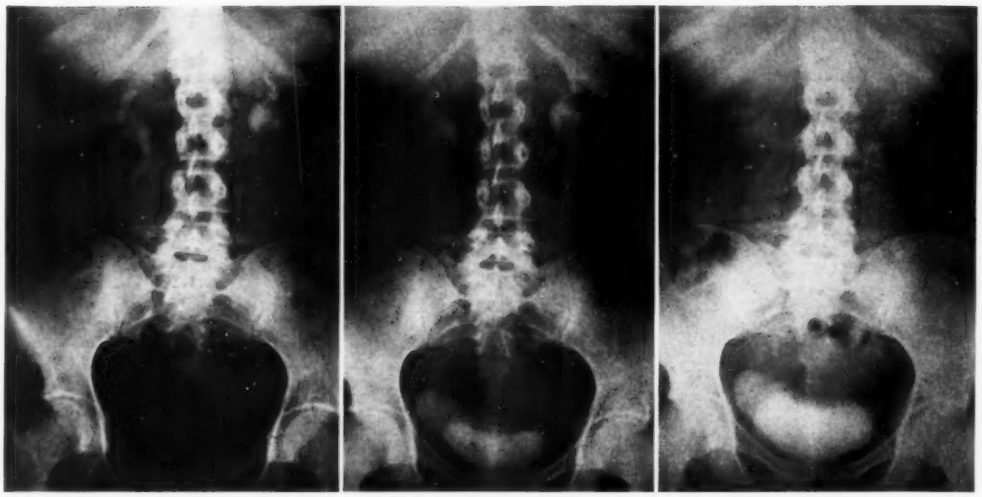

Fig. 5. Same case as Figure 4. Two months postpartum. Excretion periods 5, 15, and 30 minutes. Best delineation of pelves, calyces, and ureters at 5 minutes.

nancy in rabbits on the time after injection of intravenous pyelography media at which x-ray evidence of the greatest concentration of dye is obtained. In non-pregnant dehydrated rabbits, the best plates are obtained in from 3 to 5 minutes after injection of the media. In rabbits in the twentieth to twenty-fifth day of pregnancy, the best plates are obtained from 15 to 20 minutes after injection. Abramson, Robins, and I are now engaged in repeating this experiment, and we believe Rossi to be correct. These observations might be interpreted to indicate that there is reluctance on the part of the kidneys of the pregnant rabbit to give up the dye as promptly as in the non-pregnant. This might be construed as indicative of deficiency in the renal cortex, were it not that the calyces of the kidneys appear to fill as readily in pregnant as in non-pregnant animals. The defects in the earlier plates in pregnancy seem to be due to failure of the media to become distributed throughout the pelvis and ureter.

The third item of evidence is that which my collaborators and I have produced, and which concerns a similar delay in appearance of the "best film" in the pregnant human as compared with the normal woman of similar age group. It is generally agreed among radiologists and urologists that in non-pregnant normal individuals the best roentgenographic demonstrations are obtained soon after injection of the intravenous media. The 5 minute plate is most often the best, the 10 minute plate next in frequency, and rarely the 15 minute plate shows to best advantage (Fig. 1). In a survey of 253 pyelographies in pregnant women (1) the best plate in mid-pregnancy is most often obtained at 30 minutes after injection of the media. As early as 2½ months in pregnancy (Fig. 2), the 5 minute and 10 minute plates are oftener inferior to the 15 minute plates.

In a more advanced pregnancy (fifth to eighth month), there is a tendency to fill the calyces early, but there is noted a definite lag in distribution of the dye throughout the pelvis and ureter (Fig. 3). In the more marked stages of dilatation of the pelvis and ureter, adequate delineation of the pelvic and ureteral outlines is not obtained until after 45 minutes (Fig. 4). But soon after the termination of pregnancy, the kidneys return to their normal excretion rate (Fig. 5). In extensively changed large lesions, adequate outlining of the pelvis and ureter are not obtained until

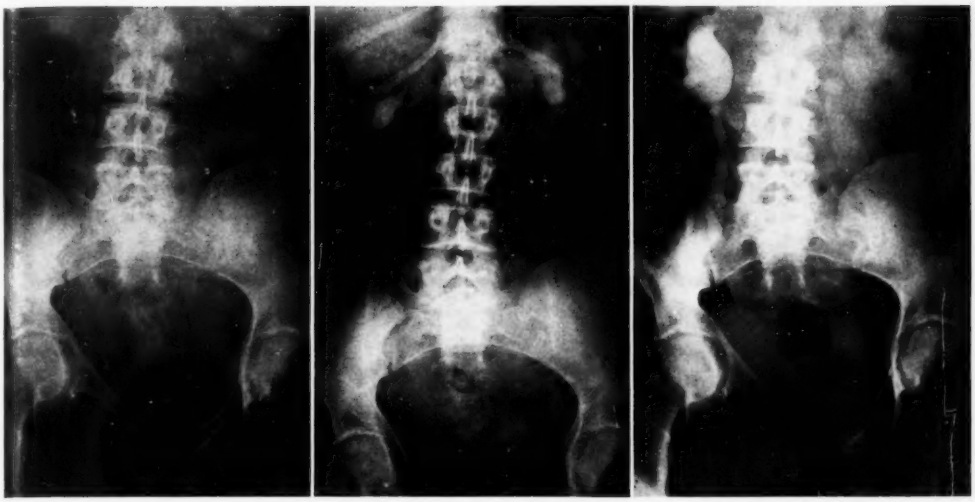

Fig. 6. Roentgenogram of tripara; unit history No. 4,343. Pyelogram made at 6 months. Complaint: bilateral pyelitis of pregnancy. Excretion intervals 5, 15, and 45 minutes. Abnormal kidney right, greater dilatation on left Calyces fill both sides at 5 minutes. Ureters first show both sides at 45 minutes.

from 45 to 90 minutes (Fig. 6). In infected cases, the calyces may not fill at all.

The fourth item of evidence is drawn from the study of the ability of pregnant women to eliminate a peak load of fluid. This evidence is produced by Janney and Walker. The conditions of their experiment were aimed at the determination of what percentage of an enormous intake of water would be excreted in a 30 minute period in normal women as controls and in women in the different weeks of pregnancy. They concluded that for normal women, intake and output volumes were identical. In pregnant women, there is a marked and progressive decrease in the ability of the kidneys to handle peak loads of fluid, which reached its lowest figure in mid-pregnancy but which showed a slight upward trend in the latter portion of pregnancy.

The fifth item is supplied by studies of motility of the pelvis and ureter by the hydrophoragraph. Traut, McLane, and Kuder produced evidence to indicate that beginning early in pregnancy, there is a progressive decrease in motility of the pelvis and ureter which reaches its lowest level in mid-pregnancy and shows an upward trend at the eighth month.

The sixth item of evidence produced is that of the clinical and experimental data concerning the curve of degree of dilatation noted in the months of pregnancy. Traut, McLane, and Kuder record in a reversed curve the degree of dilatation of pelves and ureters in contrast to the curve of motility of the musculature. This curve has its peak in mid-pregnancy and declines steadily toward the end of pregnancy.

The pyelography available for study at the Boston Lying-In Hospital, where ever repeated pyelography has been done, confirms this point of view. From purely clinical observations both incidence of pyelitis symptoms and severity of symptoms and signs occur in mid-pregnancy. It is only in the occasional case that pyelitis symptoms begin after the eighth month or are severe if they do occur.

The seventh item in support of a changed renal behavior is that supplied by laboratory data. Excretion of dyes from the kidneys as indicated by phthalein excretion or similar drugs is below normal. Sondern and Harvey first showed (1911–1912) by intramuscular injection of phenolsulfonphthalein in 18 nor-

TABLE I.—COMPOSITE CHART OF DATA ON THE TOTAL 55 CASES

Case No.	Day													Total excess ounces	No. of days	
	1	2	3	4	5	6	7	8	9	10	11	12	13			
1				20	14		29	23	19	2				107	6	
2				5			12	29		28	10			84	5	
3	17		28	46	32	56	18		17					214	7	
4		6			38				5					49	3	
5				9		36	9	10	27					91	5	
6					8			5	16					29	3	
7				10	26			10	8					54	4	Ad lib. fluids
8					8									8	1	
9	2		7	13	10	18								50	5	
10				36	12		4	2						54	4	
11		17	15	6		5		4						47	5	
12		38	15		28									81	3	
13				23	17									40	2	
14			45	1	51	32		10						139	5	
15			15	15	34	7	20	7						98	6	
16		8	23	6	38	33	17	28	6					159	8	
17		14		11	14		31							70	4	
18			29	20	5					20				74	4	
19		13	34					18					4	69	4	
20		1	9	30		2								42	4	
21						26	12	32				22		92	4	
22	Insuf	ficient	Data													
23		10						28	25					63	3	Forced fluids
24		6		12										18	2	
25					40	3	10							53	3	
26			19	13	25		11	18						86	5	
27		3	16	38	1		5							63	5	
28				1		6								7	2	
29	None													None	None	
30		4						8						12	2	
31		32	5	23	41	37	46	15		2				201	8	
32		30					2							32	2	
33								3						3	1	
34		8												8	1	
35		7	4	39	23	46								119	5	
36		20	18			45								83	3	Pre-eclamptics
37			10	50	44	30	9		16	18				177	7	
38				11		11								22	2	
39	None													None	None	
40			51		10									61	2	Infection with forced fluids
41	None													None	None	
42	None													None	None	
43								9						9	2	Urinary tract infections
44	None													None	None	

TABLE I.—Continued

Case No.	Day													Total excess ounces	No. of days	
	1	2	3	4	5	6	7	8	9	10	11	12	13			
45	None													None	None	
46					23	5								28	2	Gonococcus endocervicitis
47									1				14	15	2	
48			4	21	18	13								56	4	Retention of urine
49		33	18	22	43	21		42						179	6	
50					1	24			4					29	3	Cardiacs
51		18	21	30	21	32	26	11						159	7	
52			17	5	10		9	14		7				62	6	
53	13													13	1	Postpartum hemorrhage
54		19		12		12					12			55	4	
55				5				30						35	2	

mal women late in pregnancy that there was in all a delayed appearance time for the dye from 8 minutes in the non-pregnant to 12 minutes in the pregnant women, and a total output in 2 hours of 45 per cent instead of 75 per cent average for 18 normal non-pregnant women. There were 3 cases among the 18 in which dye excretion was greatly depressed. Yet over a period of several years' observation, non-protein nitrogen tests are noted in the Boston Lying-In Hospital to range in the low normals, as do creatinines and other tests devised to indicate storage of waste products of metabolism. It seems logical to look upon this episode in dye behavior as similar to the excretion of intravenous pyelography media. In the latter, visualization of the pyelography media gives the clue to the failure of the dye to appear in the bladder promptly or in normal quantities. If the phenolsulfonphthalein and the dye are promptly excreted through the whole glomerular and tubular units, although delayed in reaching the outer world, there is no reason why there should be retention of waste products in the blood. It has not been demonstrated that there is appreciable re-absorption of fluids or urine salts from the mucous membrane lined conducting channels of the urinary tract. Only their removal from the body after passing through the secreting unit is delayed.

Analysis of these data indicates that there is evidence of increase in blood plasma in pregnancy. Edema stands as a further manifestation of excess body fluid during pregnancy in a few.

There is a decreased ability to handle peak loads of fluids in pregnancy in normal women.

Pregnancy itself in animals (quadrupeds) and pregnancy alone but accentuated by uterine pressure does not appear to impair the excreting ability of the kidney, but impairs, through delay, the clearing of excreted urine from the renal tree.

It is therefore logical to expect storage of fluids during pregnancy and a re-adjustment in fluid balance soon after delivery.

In support of this hypothesis I have noted clinically isolated cases which indicated that there was excess excretion over intake immediately following delivery. In some instances an immense residue was found in the bladder so near to delivery, at which time the bladder had been emptied by catheter, that it seemed impossible that a sleeping patient could have taken that amount of fluid in that period of time. In one specific case, a total fluid intake of 3,765 cubic centimeters had been accompanied by an output of urine of 4,920 cubic centimeters, yet catheter revealed 1,890 cubic centimeters bladder residue in addition.

The duration of this experiment to determine fluid balance in the puerperium was terminated spontaneously by the limit of the ability of the nursing staff of the hospital to carry so accurate a recording of intake and output further. It resulted in the assembling of complete charts on 55 cases. By reference

TABLE II.—DISTRIBUTION OF DAYS OF EXCESS FLUID AFTER DELIVERY

	1	2	3	4	5	6	7	8	9	10	11	12	13	Home
Ad lib. fluids	2	3	4	9	10	4	5	7	6	2	1	0	0	
Forced fluids	0	10	9	11	9	8	9	10	2	2	0	1	1	
Pre-eclamptics	0	3	3	3	2	4	1	0	1	1	0	0	0	
Cardiacs	0	1	2	2	3	2	2	2	1	1	0	0	0	
Total of all cases	3	19	21	29	28	22	17	22	11	6	2	1	2	

	Days of excess fluid	Average excess fluid (14 days)
Ad lib. fluids	4.0	68.3
Forced fluids	4.3	114.8
Pre-eclamptics	3.6	81.8
Cardiacs	5.3	83.3
Total of all cases	3.5	77.4

to Table I it will be noted that the cases studied consisted of:

13 cases of normal delivery in normal uninfected women who had taken fluids as desired without any effort at forced fluids. Fluid range per 24 hour period was 70 to 100 ounces.

19 cases which emerged from delivery on forced fluids with a range of intake above 100 ounces.

5 pre-eclamptic cases, some of which had been dehydrated; others were taking fluids ad lib.

4 infection cases with onset of infection soon after delivery. Fluids were gradually and steadily forced until the intake rose to 150 ounces or above.

2 urinary tract infection cases which were on forced fluids similar to group No. 4.

3 gonococcus endocervicitis cases in which fluids were ad lib.

2 cases of retention of urine which were treated for but a few days by catheterization. Fluids ad lib.

3 cardiac cases in which restricted fluids with intake between 40 and 70 ounces per day had been the routine.

3 cases in which postpartum hemorrhage had occurred. Forced fluid was instituted and transfusion employed.

In 1 case the data were insufficient for determining the fluid relation.

In the whole group there were but 6 instances in which, for a period of from 1 to 8 days, there was not some time during which the intake of fluid was not exceeded by the output of urine. This phenomenon occurred even though the record of all other fluid losses attendant upon delivery and lactation were not included. This observation would in itself establish as a fact the presence of a definite fluid re-adjustment which regularly follows pregnancy and delivery. The figure is further strengthened by the necessary exclusion of 5 of the 6 cases in which the curves did not cross because of fever and forced fluids. It is well established that in febrile cases output of fluid through the urinary channels is markedly depressed. If in addition fluids are rapidly increased, the intake curve far outstrips the output curve. Yet in spite of such rapid increase in intake in febrile cases, the output curve appears to bear an abnormal relation to the intake curve in that it frequently approaches very near to crossing it in a relation which is not encountered in similar febrile conditions in the non-pregnant. The relation of output to intake in these febrile cases was not studied beyond the 14 day period previously designated; there may have been a delayed re-adjustment.

In the chart of the remaining one normal individual whose output did not at any time exceed her intake, there is noted the same tendency for the output to approach abnormally near the intake on certain days.

It is evident that if, among the many losses of fluid attendant upon delivery and the puerperium, lactation alone was included in fluid loss in addition to urinary output, the figures would appear abnormal to even a more astonishing degree.

Analysis of Table I and reference to Table II show that fluid excess is occasionally noted during the first 24 hour period after delivery, is very commonly present on the second day,

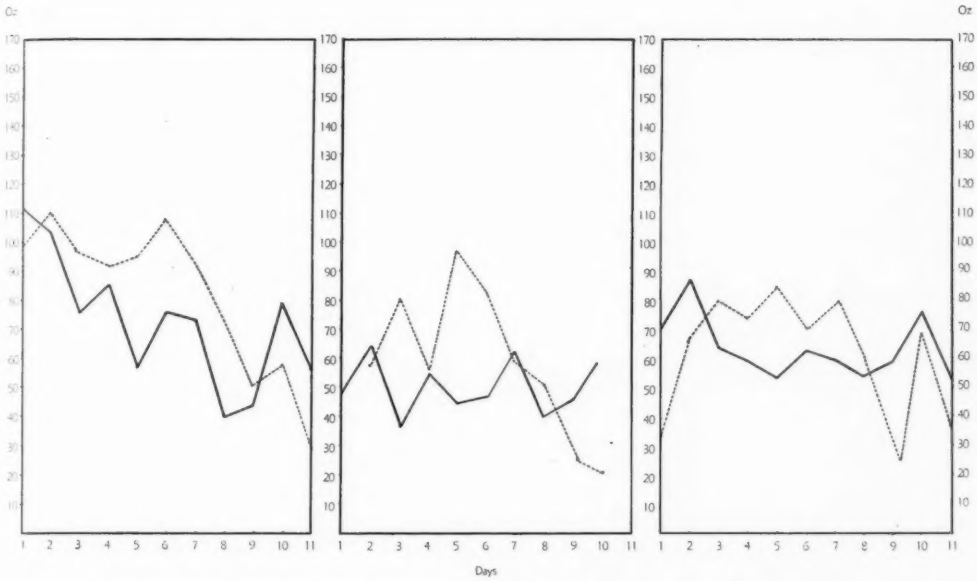

Fig. 7. Charts of 3 typical cases showing fluid balance of patients which emerge from delivery on fluids ad lib. M. A. secundipara, upper respiratory infection, afebrile. S. B., secumdipara, afebrile. E. E., primipara, afebrile.
———intake; .....output

but that the third, fourth, fifth, and sixth days show greater frequency of excess and greater amounts of excess.

Total excretion of fluid in excess of intake was but 13 times under 30 ounces. Nine times it exceeded 100 ounces, and twice exceeded 200 ounces.

Reference to Table I reveals that it makes little difference in the number of days of excess secretion as to whether the patients emerge from delivery on ad lib. fluids or on forced fluids. The figures are 4.0 days for the former and 4.3 days for the latter. There is, however, a larger amount of fluid handled. The average total excess excretion for the ad lib. group is 68.3 ounces and for the forced fluid group 114.8 ounces.

In 2 other groups there might be factors outside those prevalent in normal pregnancy which might influence the relation of intake and output curves. Both groups are small; they are the pre-eclamptics and the cardiacs, 5 of the former and 3 of the latter. The endocrine state is definitely variant from that in normal pregnancy in the eclamptics. In spite of this variation the total excess fluid exceeded 83 ounces in 3 of the 5, and exceeded 100 ounces in 2 of the 5.

The cardiacs might be considered as more likely to store fluids because of impaired circulation. They were also kept on greatly restricted intake of fluid. In spite of the latter, they were above the average in total fluids excreted, and excreted an excess for a greater number of days with an average for the 3 cases of 5.3 days.

I question whether it is possible so to restrict fluids in afebrile conditions in pregnancy that there is not produced a fluid storage in the course of the pregnancy, which is adequate to meet the fluid losses attendant upon delivery and the establishment of lactation in the puerperium if fluids are not curtailed up to the limits of deprivation.

A better graphic image of the nature of the disturbed fluid balance in the puerperium can be obtained by reference to the individual charts which are appended (Figs. 7, 8, 9).

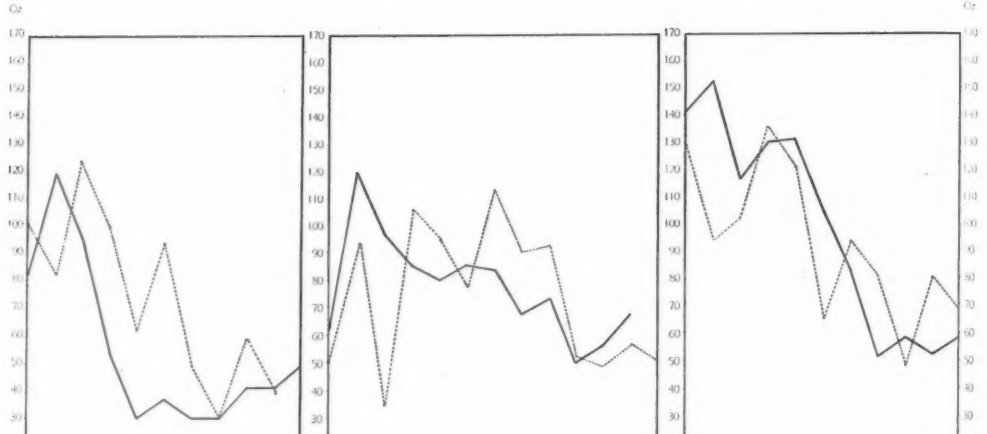

Fig. 8. Charts of 3 typical patients showing fluid balance when they emerge from delivery on forced fluids. O. A., quadripara, retention of lochia, low fever eleventh and twelfth days. C. O'B., secundipara, afebrile except for slight rise eleventh day, normal thirteenth day. E. W., secundipara, afebrile, 36 weeks pregnant. ———intake; . . . . . output

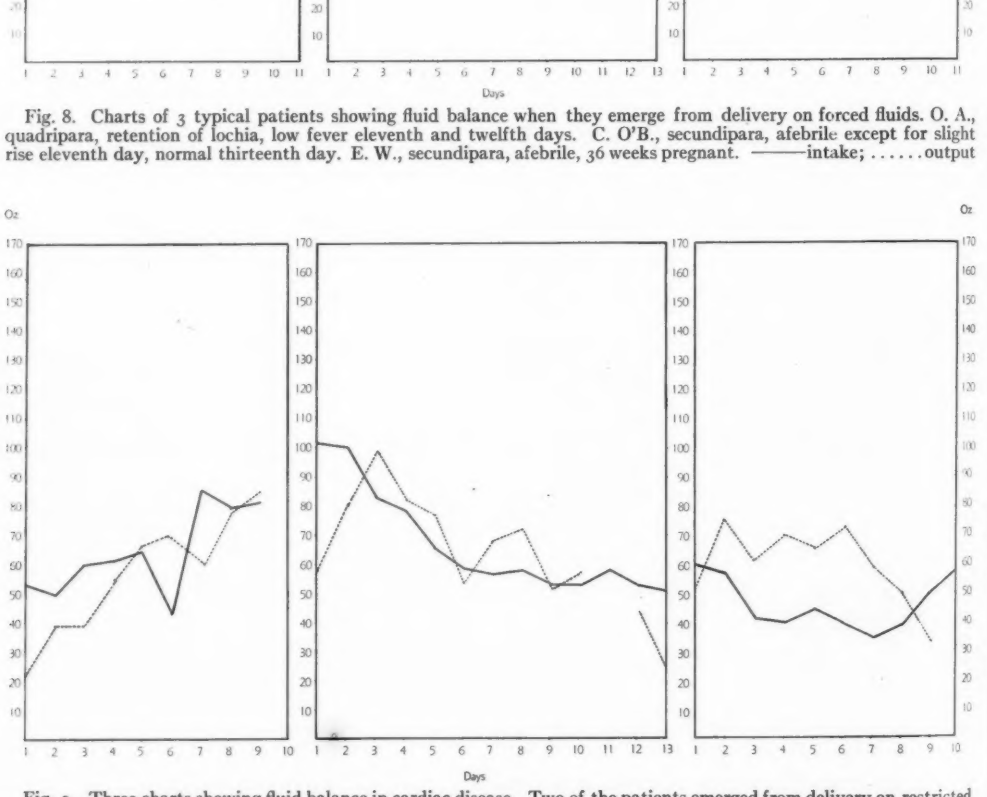

Fig. 9. Three charts showing fluid balance in cardiac disease. Two of the patients emerged from delivery on restricted fluids. A. D., tripara, class III cardiac, postpartum hemorrhage, fever fifth and eleventh days. R. C., primipara, class II cardiac, dystocia, secondary uterine inertia, deformed pelvis, afebrile. R. G., secundipara, class I-A cardiac, afebrile. ———intake; . . . . . output

I shall not attempt to indicate the possible significance of fluid storage in pregnancy in relation to medical practices on pregnant women. Those who are better qualified in the various fields of medicine can best do that. That it has bearing on urinary infection in pregnancy, the treatment of cardiac cases in pregnancy, the management of eclamptics, and the demonstration of less need for attempting to maintain fluid reserves in postpartum conditions, is obvious.

I cannot refrain from observing that residual urines and retentions of large size may quickly occur wherever the response of the bladder to normal sensations is reduced as a result of bladder injuries caused by delivery or narcosis anesthesias. The relation of output to intake is no longer to be considered a safe guide as to the magnitude of the bladder content. Large bladder content if uninfected is of less significance than when infected. If infected, a postpartum febrile condition can be expected to occur with either retention or large residual urine formation. Theoretically, postpartum pyelitis can be considered entirely the result of faulty bladder management. It should be preventable. This increment of knowledge confirms me in my long established routine of placing on constant drainage those infected bladders and after 3 days of intermittent catheterization most uninfected bladders as soon as the fact of faulty emptying is established. I do not believe that the average nurse or obstetrician can palpate or percuss residual urine unless of large amount. Early catheterization of sleeping patients to prevent gross overdistention and subsequent atony is justified. Catheterization by the clock as is frequently practised is inconsistent with the demonstrated fluid excretion characteristics in the puerperium.

CONCLUSIONS

1. Pressure of the gravid uterus upon the ureters is not adequate to explain the changes in the renal tree which commonly occur in pregnancy.

2. A double etiology for these changes, if considered both as to nature and degree, should be accepted for humans. An endocrine factor should be given equal if not greater significance than the pressure factor.

3. There are several established lines of evidence which have in common certain characteristics in relation to the stage of pregnancy, which indicate that fluid storage in the course of pregnancy should occur regularly and in all cases.

4. In all except 1 of 54 cases studied over the average 14-day stay in the hospital after delivery, except in 5 febrile cases, there is an output of urine in excess of fluid intake too large and of too long duration to be considered accidental.

5. If fluid losses attendant upon delivery and the puerperium, purely obstetrical in nature, and lactation, be included, the above figures will be greatly exaggerated.

6. Medical and surgical and urological diseases, when they develop either in the course of pregnancy or the puerperium, should be considered in relation to a disturbed fluid balance and not by the yard stick of fluid balance in the non-pregnant.

REFERENCES

1. Crabtree, E. Granville. Hydronephrosis in pregnancy. J. Urol., 1937, 38: 605. Read at the meeting of the American Urological Association, 1937.
2. Crabtree, E. Granville, Prather, George C., and Prien, Edwin L. Am. J. Obst. & Gynec., 1937, 34: 405.
3. Janney, J. C., and Walker, E. W. J. Am. M. Ass., 1932, 99: 2078–2083.
4. Rossi, V. Arch. Ital. di Urol., 1936, 8: fasc. 3.
5. Rowntree, Leonard G. Physiol. Rev., 1922, 2: 116–169.
6. Sondern, Frederick, and Harvey, Thomas W. The phenolsulfonphthalein test for estimating renal function in pregnancy. Bull. Lying-In Hosp., City of New York, 1911–1912, 8: 172–175.
7. Traut, H. F., McLane C. M., and Kuder, A. Surg., Gynec. & Obst., 1937, 64: 51.

CARCINOMA OF THE BODY OF THE UTERUS

A Clinical and Pathological Review

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THIS study was undertaken with the object of reviewing and evaluating results in the treatment of carcinoma of the corpus uteri at The Barnard Free Skin and Cancer Hospital. It covers the years 1919 to 1936, within which period approximately 100 patients with corpus carcinoma presented themselves for treatment. The case records from the earlier years in which the histories or follow-up were incomplete were discarded, leaving 88 cases which form the basis of this report. In this group, 98 per cent had a complete follow-up and 80 per cent of the gross specimens were available for study.

Race distribution. It is generally assumed that carcinoma of the corpus uteri has a higher incidence in the colored race. Our figures, however, show that 73 per cent of the patients were white, despite the fact that over one-third of the total number of clinic patients are colored, and the figures show a high incidence of myomatous uteri in both races. It was noted that a high percentage of the patients with carcinoma of the uterus were obese and overweight.

TABLE I.—AGE INCIDENCE

Age in years	No.	Per cent
Under 30	1	1.15
30 to 40	4	4.54
40 to 50	26	29.54
50 to 60	24	27.27
60 to 70	25	28.40
70 to 80	8	9.09

Age incidence. Table I shows the age on admission of patients with carcinoma of the uterus. The youngest patient was 19, and the oldest was 77. The highest incidence occurred in the fourth and sixth decades; 22, or 25 per cent had not reached the age of 49. This corresponds with the recently published statistical study of Norris and Dunne, and illustrates the fact that corpus carcinoma occurs more frequently in the earlier decades than is generally assumed.

Hereditary factors. In such a small series, any factors dealing with heredity are necessarily inconclusive. A family history of cancer was obtained in 9 cases, or 12 per cent. It is of interest to note that in 5 of these cases there was a history of carcinoma on the maternal side.

Effects of gestation. The literature bears frequent reference to the influence of gestation on the incidence of carcinoma of the cervix (3, 13). The associated frequency of cervical irritation is considered a factor. In the case of corpus carcinoma, however, there is no evidence to show that gestation has any etiological significance. Our figures support this view, as the cases were almost equally divided between nulligravidas and multigravidas.

Symptoms and duration. The predominant symptom was vaginal bleeding which did not correspond to any particular type. It averaged 9 months in duration prior to the beginning of treatment. Pain was a late manifestation of the disease.

Relation to menopause. Krieger, in a study of 2,291 cases, concluded that the average age of menopause is 47 years. Fifty-five patients in our series were past this age. Of these patients 85.5 per cent had not yet reached the menopause at 47 years, and 54.5 per cent of them were still actively menstruating at the age of 50; while in 20 per cent this function persisted up to the age of 53 years. In one instance menopause was delayed until 60 years. This corresponds to the findings of Crossen and Hobbs in a similar series, and illustrates the fact that late menopause is a common observation in women, who develop adenocarcinoma of the corpus. These authors found that the incidence of late menopause in such cases was 4 times as high as it is in normal cases. This suggests that a woman, who men-

From the Gynecological Clinic of The Barnard Free Skin and Cancer Hospital.
Read before the conjoined meeting of the St. Louis and Chicago Gynecological Societies, February 13, 1937.

TABLE II.—CLASSIFICATION AND TREATMENT OF ALL CASES

	Operable	Inoperable	Total
Number treated	65*	23†	88
Histological grading			
Grade I	21	0	21
Grade II	24	5	29
Grade III	20	18	38
Type of treatment			
Abdominal hysterectomy	32	8	40
Vaginal hysterectomy	26	2	28
Hysterectomy plus radiation	19	10	29
Radiation only	7	13	20

*73.86 per cent; †26.14 per cent.

struates beyond the age of 48 years, should be closely followed and the possibility of endometrial malignancy kept in mind.

Associated hyperplasia. Hyperplasia of the endometrium is a frequent finding in women with a late menopause, and may be a predisposing factor in the development of malignant changes. In 17 of our cases the histological sections showed an associated hyperplasia. One of these had been diagnosed as a case of endometrial hyperplasia from a curettage performed 12 months previous to the finding of positive evidence of malignancy.

Incidence of myomas. While 35.2 per cent of our fundus cancer cases had associated myomas, only 5.6 per cent of the total number of patients with fibromyoma treated within the same period had associated carcinoma. This still leaves unanswered the question of the etiological relationship between uterine fibromyomas and fundus cancer.

Associated pathology—metastases. Howard Taylor finds that breast carcinoma is associated with fundus carcinoma in the proportion of 1 to every 130 cases of the latter. In this small series, the incidence was somewhat higher, since there were 5 patients who had been previously treated for adenocarcinoma of the breast. One of these died 3 months following treatment, and at autopsy, in addition to the uterine adenocarcinoma, fibrosarcoma of the uterus, lung, and liver was present. The ovary was found to be involved in 4 cases. One of these showed a fibrosarcoma, while in another a granulosa cell tumor was found. This latter case invites speculation upon the relationship between excess ovarian hormone and the pathological changes occurring in the endometrium.

TABLE III.—CLASSIFICATION AND TREATMENT OF CARCINOMA OF THE BODY AND CERVIX OF THE UTERUS

	Operable	Inoperable	Total
Histological grading			
Grade I	2	0	2
Grade II	4	0	4
Grade III	4	1	5
Total	10	1	11*
Type of treatment			
Abdominal hysterectomy	8	0	8
Vaginal hysterectomy	2	0	2
Hysterectomy plus radiation	3	0	3
Radiation only	0	1	1

*Incidence, 12.5 per cent.

Classification of cases. The comparison of results of different methods of treatment is of little value unless it deals with a uniform type of material. The rate of cure will necessarily vary with the care with which the primary material is selected and the principles which form the basis for selection. The importance of separating the operable cases when reporting results, has been stressed by Heyman (9) and Arneson, particularly when an attempt is being made to evaluate surgery and irradiation.

The clinical classification is further complicated by the fact that there exists a group of cases in which cancer can be demonstrated anatomically and histologically, in both corpus and endocervix. Heyman (10), who first drew attention to this, states that the possibility of comparing different statistics on corpus carcinoma will be entirely ruined if one clinic places these with the corpus cancers and another clinic groups them under the cervical cancers. He applies the term *carcinoma corporis et colli* to this type of lesion and classifies them separately under this heading. In the

TABLE IV.—SURVIVAL RATE—TEN YEAR RESULTS

	Operable	Inoperable	Total
Total cases, 1919–1926	12	4	16
Survival in years			
1	11	3	14
2	8	2	10
3	7*	1†	8
4	7	1	8
5	6‡	1	7
6	3	0	3
7	3	0	3
8	3	0	3
9	3	0	3
10	3§	0	3

*58.33 per cent; †25.0 per cent; ‡50 per cent; §25.0 per cent.

TABLE V.—SURVIVAL RATE—FIVE YEAR RESULTS

	Operable	Inoperable	Total
Total cases, 1919–1931....	20	12	32
Survival in years			
1.....	17	6	23
2.....	14	4	18
3.....	12*	3†	15
4.....	11	3	14
5.....	10‡	3†	13

*60.0 per cent; †25.0 per cent; ‡50.0 per cent; §25.0 per cent.

Stockholm Clinic 50 per cent of these cases are found to be advanced lesions involving the entire uterus, but about 25 per cent are early, without palpable changes. At the Radiumhemmet, special attention is paid to the recognition of this group of cases. This is accomplished by the routine performance of a fractional curettage of the uterus. In this procedure the cervix is curetted before dilatation, then the fundus, and then the lower segment, the curettings being collected in separate bottles. We have found it more practical to curette the lower segment of the uterus before exploring the fundus. This procedure also furnishes information on the site and extent of the lesion, which may be of practical value if the case is to be irradiated.

We have classified our cases into operable and inoperable groups, and have included the body and cervix cases in a separate group. The operability was predicated upon the extent of the disease, and in each case was verified by the chief of service.

Histological grouping. The histological classification comprises three groups. An analysis of the end-results did not show sufficient divergence to warrant the separation of Group 1 cases into papillary adenoma malignum and adenoma malignum. It was, therefore, deemed more practical to adopt the criteria of Haagensen (5) in preference to that of Mahle, Healy and Cutler (8), et al. Groups 1, 2, and 3 comprise the mature, intermediate, and anaplastic types, respectively.

Treatment. Complete removal of uterus, adnexa, and a short vaginal cuff under spinal anesthesia has been considered the treatment of choice. Table II summarizes the classification and treatment of all cases. It shows that 73 per cent of the patients were considered operable at the onset of treatment.

TABLE VI.—SURVIVAL RATE—THREE YEAR RESULTS

	Operable	Inoperable	Total
Total cases, 1919–1933....	31	15	46
Survival in years			
1.....	27	8	35
2.....	23	4	27
3.....	21*	3†	24

*67.4 per cent; †20.0 per cent.

Vaginal hysterectomy, under local anesthesia, was employed in a large percentage of those cases, termed technically operable which otherwise would be considered inoperable on account of some intercurrent disease or debility. In these, the Schuchardt incision was at times employed to facilitate exposure. The total operative mortality was 3.4 per cent. In accordance with the improved results reported in the literature (2, 7, 17), from the use of radium pre-operatively, we have latterly adopted this method in the treatment of the anaplastic lesions. The maturity of the lesion was not an important factor in the operable group, as the three histological grades were approximately equally distributed. In the inoperable group, however, there was a predominance of the anaplastic type of growth. The patients in this group were treated with radium alone, or radium in combination with surgery. In 10 of them an intra-uterine application of radium produced sufficient clinical improvement to justify subsequent operation. It is of interest to note that our indications for operability have remained approximately the same for the past 17 years, and parallel that of Heyman in a series of 156 cases in which patients were treated with radiation alone.

Table III summarizes the cases of cancer of the body and cervix of the uterus. The percentage incidence was only 12.5 per cent as compared with an average incidence of

TABLE VII.—SURVIVAL RATE, IN CASES OF CARCINOMA OF BODY AND CERVIX OF UTERUS

	Number	Per cent
Total cases, 1919–1933.....	6	
Survival in years		
1.....	4	66.66
2.....	3	50.00
3.....	2	33.33
4.....	2	33.33
5.....	2	33.33
10.....	1	16.66

26 per cent in the Radiumhemmet. It will be noted that all but one of these were operable cases and only one-half were immature lesions. Three of them displayed a separate small growth at the fundus, including one which had received radiation for adenocarcinoma of the cervix at another clinic 2 years previously. We believe that the possibility of involvement of the corpus in adenocarcinoma of the cervix is not sufficiently stressed and that the fundus should always be explored.

It is recognized that any woman manifesting abnormal uterine bleeding should have a diagnostic curettage. Immediate hospitalization was often impossible in our overcrowded institution, and in consequence of this, we have recently been using the Randall biopsy cannula. This has proved an efficient and convenient method for obtaining endometrial biopsies in the clinic at the first visit. Plentiful material can be thereby removed for examination, and the patient enters the hospital with the diagnosis confirmed, ready for treatment. The possibility of missing a small localized area of cancer should always be kept in mind and a thorough curettage is indicated in doubtful and suspicious cases.

Results. Tables IV, V, and VI give the results of treatment over 10, 5, and 3 year periods, respectively. A considerable percentage of the patients came under treatment during the past 3 years and had to be eliminated from the calculations. In the operable group a 10 year survival rate of 67.7 per cent was achieved. In the inoperable group, no patients survived 10 years, and the 5 and 3 year cure rate was reduced to 20 per cent and 25 per cent, respectively. These results compare favorably with similar reported series (1) in which radiation was the only treatment used.

Table VII shows the survival rate of the body and cervix cases. All but 1 were in the operable group, yet only 1 lived 10 years, thus reducing the 5 year survival rate to 33.3 per cent.

SUMMARY AND CONCLUSIONS

1. An attempt is made to correlate the clinical and pathological findings in 88 cases of corpus carcinoma selected from the records of the Barnard Free Skin and Cancer Hospital.

2. Seventy-three per cent occurred in the white race.

3. The highest incidence was equally divided between the fourth and fifth decades.

4. Gestation does not seem to be a factor in the predisposition to corpus carcinoma.

5. A family history of cancer was present in 12 per cent of the cases, of which more than half were directly attributed to the maternal side.

6. Late menopause is a common observation in women who develop fundal cancer.

7. There is reasonable evidence for the assumption that there is a relation between hyperplasia of the endometrium and fundus carcinoma.

8. The fundus should be explored in all cases of adenocarcinoma of the cervix.

9. Operation has been the treatment of choice. Recently use of radium before operation has been employed in the treatment of anaplastic lesions.

10. Results are calculated on the basis of 10, 5, and 3 year survivals. The poorest results were in the corpus and cervix cases, although a majority of the latter were not advanced cases.

REFERENCES

1. Arneson, A. N. Am. J. Roentgenol., 1936, 36: 4.
2. Bowing, H. H., and Fricke, R. E. Am. J. Roentgenol., 1931, 26: 738.
3. Crossen, H. S. Am. J. Obst. & Gynec., 1933, 26: 686.
4. Crossen, R. J., and Hobbs, J. E. J. Missouri M. Ass., 1935, 32: 361.
5. Haagensen. Am. J. Cancer, 1933, 19: 285.
6. Hanseman. Quoted by Haagensen.
7. Healy, William P. Am. J. Obst. & Gynec., 1934, 1: 27.
8. Healy, William P., and Cutler, Max. Am. J. Obst. & Gynec., 1930, 19: 457.
9. Heyman, James. Acta Radiologica, 16: No. 90.
10. Idem. Proc. 4th Int. Rad. Congress, Zurich, 1934.
11. Krieger. Die Menstruation. Quoted by Meissner and De Lee.
12. Mahle, A. E. Surg., Gynec. & Obst., 1923, 36: 385.
13. McGlinn, J. A. Am. J. Obst. & Gynec., 1935, 29: 619.
14. Norris, C., and Dunne, F. Am. J. Obst. & Gynec., 1936, 6:982.
15. Taylor, Howard. Am. J. Cancer., 1931, 1: 277; 3: 15.
16. Zweifel, E. Ztschr. f. Geburtsh. u. Gynaek., 1933, 104: 498–515.
17. Report on Cases Treated at the Radiumhemmet. 1921–1935, p. 51–104.

THE TREATMENT OF COLON BACILLUS PERITONITIS IN RABBITS WITH ESCHERICHIA COLI ANTISERUM

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IN RECENT years considerable interest has been aroused in the use of serum in the treatment of peritonitis.

The preparations most commonly used have been polyvalent mixtures of various types of antisera. Weinberg (7) and Priestley (2, 3) have reported encouraging results in the treatment of diffuse peritonitis in human subjects using a polyvalent anaerobic serum, a colon bacillus serum, and a so called complementary serum against staphylococcus and streptococcus. Vincent, Weinberg and Prevot, and Perrando have also reported the use of combinations of anticolic bacillary serum with other serums with good results both experimentally and in clinical practice.

Although these reports are favorable, there is as yet very little experimental evidence as to the value of any type of antiserum in the treatment of peritonitis. Furthermore, since peritonitis as encountered in clinical practice is usually a mixed infection, it is difficult to say which type of serum should be the most effective.

In any peritonitis resulting from the perforation of the gastro-intestinal tract, the colon bacillus is practically always one of the invading organisms. In an attempt to investigate experimentally the possibility of bactericidal power in a colon bacillus serum, we have conducted a series of experiments using a colon bacillus antiserum in the treatment of a pure colon bacillus peritonitis in rabbits.

Experimental procedure. Twenty-three rabbits were actively immunized by repeated intravenous injections of a stock colon bacillus suspension as an antigen. Agglutination titres were checked and found to range between 1:2000 and 1:10,000 after the last injection.

The 23 immune animals together with 10 controls were given an intraperitoneal injection of colon bacillus gum tragacanth peritonitis producing mixture. The mixture was prepared as described by Steinberg and Goldblatt. Eleven 6 inch agar slants incubated for 20 hours were harvested in 20 cubic centimeters of saline. An equal amount of 5 per cent gum tragacanth was added to the suspension and stirred until a homogeneous mixture was obtained. The lethal dose of this preparation was found to be 2 cubic centimeters per kilogram of rabbit weight. All inoculations of this material were given intraperitoneally.

The 10 controls receiving the peritonitis producing mixture died within 14 hours. Two of the 23 immune animals died within 20 hours. The 21 other rabbits survived with no ill effects. This observation would seem to be strong evidence that the antigen injected animals had developed an active immunity against the colon bacillus.

These surviving rabbits were sacrificed for serum. Sufficient 1:20 merthiolate solution was added as a preservative to give the serum a terminal dilution of 1:100,000 merthiolate. The combined serum of the 21 rabbits was found to give an agglutination titre of approximately 1:2000.

Treatment of rabbits with colon bacillus antiserum. Ten groups of rabbits were given a lethal injection of colon bacillus gum tragacanth peritonitis producing mixture and treated with the anticolibacillary serum. The number of animals in each group, including 2 or more controls, varied from 3 to 6. In order to simplify the data, the 10 groups of animals are combined in the following table.

A total of 24 rabbits received *intravenous* injections of serum. Twelve animals were given 1 injection of 5 cubic centimeters per kilogram of anticolibacillary serum 5 minutes after intraperitoneal injection of peritonitis producing mixture. Of these 12 animals, 5 died and 7 survived. The 12 other animals treated intravenously received 2 injections of

From the Research Division, Indiana University School of Medicine (The Eli Lilly Research Fellowship).

5 cubic centimeters per kilogram of anticolibacillary serum at 5 minutes and 6 hours after intraperitoneal injection of peritonitis producing mixture. Of these 12 animals, 9 survived, and 3 died.

Ten rabbits were treated *intraperitoneally* with anticolibacillary serum. Three of these received one injection of 5 cubic centimeters per kilogram of antiserum 5 minutes after peritonitis producing mixture was injected. All 3 animals died. The 7 other animals received 2 injections of 5 cubic centimeters per kilogram of antiserum 5 minutes and 6 hours after injection of peritonitis producing mixture. Only 1 of the 7 animals survived.

Thirty-one controls were used in these experiments. Eight of the controls received normal rabbit serum intravenously in similar doses to the animals treated with anticolibacillary serum intravenously, and 8 others received physiological salt solution by the same route and dosage. Fifteen others were untreated. All controls died within a period of 18 hours. Necropsy revealed a serosanguineous peritonitis in all animals that died. Rabbits weighing approximately 2 kilograms were used throughout.

Results of blood cultures. Blood cultures were taken on 15 of the rabbits which were treated intravenously with anticoli serum. All of the cultures were taken at 6 hours and previous to a second injection of serum. Five of these treated animals died and all had positive blood cultures. Of the cultures examined from the 10 surviving rabbits, 4 were positive at 6 hours, and 6 were negative. Cultures were again taken at 24 hours on the surviving animals and all were negative. All cultures were checked routinely up to 72 hours.

Blood cultures taken 6 hours after injection from 5 of the animals treated intraperitoneally were all positive for colon bacillus. All these animals died.

Blood cultures were taken on 15 of the controls. All cultures were taken at 6 hours, and all were positive. All died with a terminal septicemia.

The possibility of saving rabbits by waiting over 5 minutes before beginning specific intravenous therapy was considered. Two animals were treated at 1 hour, and 2 at 2 hours, and 2 animals at 3 hours after intraperitoneal injection of peritonitis producing mixture. All animals received 2 injections of 5 cubic centimeters anticolibacillary serum per kilogram. The first injection was given at 1 hour, 2 hours, or 3 hours as previously designated. The second injection was given 2 hours later. All animals succumbed along with the controls.

In the preceding experiments the peritonitis producing mixture was prepared from the same strain of colon bacillus as was used to prepare the serum. We have recently treated a few animals with a concentrated anticolibacillary serum prepared as recommended by Shwartzman.[1] The strain of colon bacillus used to produce peritonitis in this group of animals was isolated from the peritoneal cavity of a dog with peritonitis. The Shwartzman anticoli serum agglutinated this organism in a dilution of 1 to 200. Three series of animals were treated. Twelve animals each received two intravenous injections of 2 cubic centimeters of Shwartzman anticoli serum 5 minutes and 6 hours after injection. Six controls received the same amount of normal horse serum. Seven of the group of the 12 treated animals survived. All controls died within 16 hours as shown in Table II.

RESULTS OF STUDY

The type of peritonitis we have produced by this experimental procedure is not com-

TABLE I.—RABBITS INJECTED WITH COLON BACILLUS GUM TRAGACANTH PERITONITIS PRODUCING MIXTURE, SHOWING THE EFFECT OF TREATMENT WITH COLON BACILLUS ANTISERUM

Treatment	Number rabbits	Survivals	Deaths	Mortality per cent
Bacillus coli antiserum intravenously	24	16	8	33.3
Bacillus coli antiserum intraperitoneally	10	1	9	90.0
Normal rabbit serum intravenously	8	0	8	100.0
Normal salt solution intravenously	8	0	8	100.0
Untreated	15	0	15	100.0

[1]We express our appreciation to the Research Laboratories of Eli Lilly Company for supplying this serum.

TABLE II.—RABBITS TREATED WITH SHWARTZMAN ANTICOLIBACILLARY SERUM AFTER INJECTION OF BACILLUS COLI GUM TRAGACANTH PERITONITIS PRODUCING MIXTURE

	Anticolibacillary serum intravenously	Controls
Number of rabbits	12	6
Survivals	7	0
Deaths	5	6
Mortality (per cent)	41	100

parable to that encountered in human subjects; and we are making no effort to discuss clinical application at this time. The results we have reported would seem to indicate strongly that the serums used have a definite antibacterial action against the colon bacillus. However, we are not in a position to discuss the mechanism of therapeutic action. Information gained from blood culture studies would seem to indicate that the serum acts in some manner to prevent an overwhelming terminal septicemia.

CONCLUSIONS

1. Rabbits actively immunized against the colon bacillus were able to survive in high percentage a colon bacillus peritonitis produced by intraperitoneal injection of a mixture which was fatal to controls.

2. A majority of animals may be saved from diffuse bacillus coli peritonitis if treated immediately with anticolibacillary serum intravenously. The mechanism of therapeutic action apparently depends upon the fact that the serum in some way prevents an overwhelming invasion of the blood stream.

BIBLIOGRAPHY

1. PERRANDO, G. Die seruntherapie der akuten peritonitis Vlinisch experimentalles Beitrog. Zentralbl. f. Chir., 1935, 62:85–88.
2. PRIESTLEY, J. Serum therapy as adjunct to surgical treatment of appendicitis with rupture and peritonitis. Preliminary report. Proc. Staff Meet. Mayo Clinic, 1933, 8: 753–755.
3. Idem. Further observations on serum therapy in treatment of peritonitis secondary to appendicitis. Proc. Staff Meet. Mayo Clinic, 1936, 11: 213–214.
4. SHWARTZMAN, GREGORY, and WINKELSTEIN, ASHER. A new type of serum therapy for the treatment of non-specific ulcerative colitis. Am. J. Digest. Dis., 1934, 1: 582.
5. STEINBERG, B., and GOLDBLATT, H. Studies on peritonitis; production of experimental peritonitis and survival following intraperitoneal injection of Bacillus coli. Arch. Int. Med., 1927, 39: 446–448.
6. VINCENT, H. Medical applications of anti-colibacillary serum. Am. J. M. Sc., 1932, 183: 301–309.
7. WEINBERG, M. Serotherapie de l'appendicite gangreneuse et de la peritonite. Compt. rend. Acad. d.sc., 1933, 197: 497–499.
8. WEINBERG, M., and PREVOT, A. R. Du serum anticolibacillaire, Compt. rend. Soc. de biol., 1934, 116: 1269–1270.

THE ANATOMICAL AND SURGICAL FEATURES OF ECTOPIC KIDNEY

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ANOMALOUS human organs are frequently of more than anatomical importance, since their occurrence may produce a disturbed physiology, and so ultimately require surgical removal.

Among the most striking of congenital anomalies is the ectopic kidney. A kidney may be classified as ectopic by virtue of its aberrant location, its odd shape, short low pedicle, anterior pelvis or short ureter. The location has been described by Braasch as pelvic, iliac, or abdominal. The short ureter and the bizarre pelvis and calyces aid in distinguishing between an ectopic and a ptotic kidney.

On account of their varieties ectopic kidneys have received clinical consideration by many writers; excellent studies have been published by Thomas and Barton, Thompson and Pace, MacKenzie and Hawthorne, Judd and Harrington, Campbell, and many others. Ectopic kidney is not uncommon; the occurrence of 154 has been recorded in a total of 128,322 autopsies, an incidence of 1 in 833[1]; but, since published accounts of excised surgical specimens are not numerous, it was considered advisable to place on record the current case of renal ectopia. The presence in the dissection laboratory of an excellent example of ectopia furnished an opportunity to follow in detail the anatomical relations of abnormal, and associated normal, kidney—particularly those important relations having to do with the arterial supply and venous drainage.

Both the anatomical and the surgical specimens were characterized by the possession of an anterior pelvis; each was low in position with short ureter; each had a complex arrangement of renal vessels. In the anatomical specimen no hydronephrosis was evident; in the surgical specimen a marked intrarenal hydronephrosis occurred, the result of infundibular constriction produced by anomalous renal vessels.

ANATOMICAL SPECIMEN

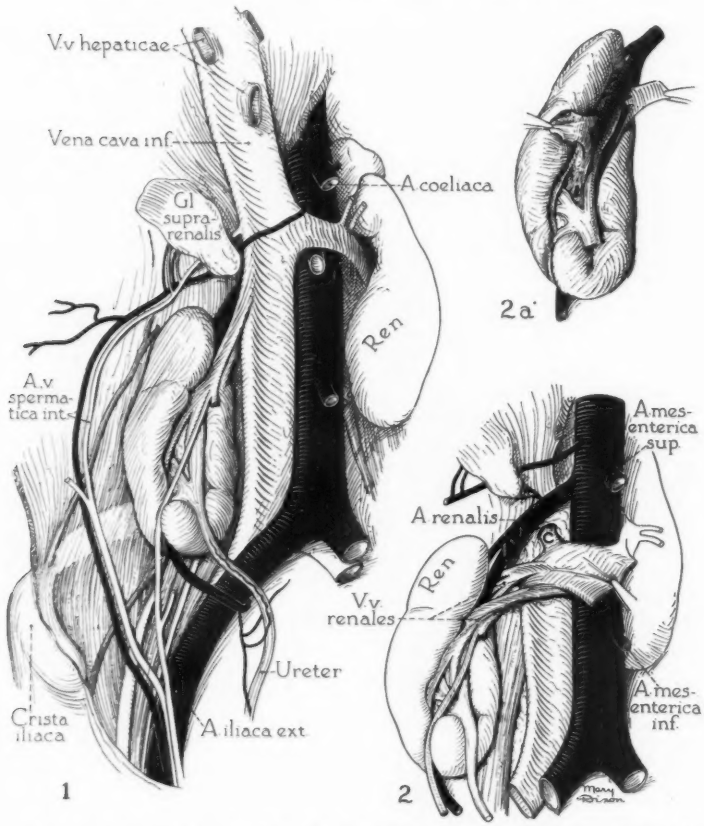
The cadaver in which the anatomical specimen was studied was a muscular, male negro, 5 feet 11 inches in height, weighing 121 pounds (embalmed), and aged 70 years. Figures 1 through 7 show successive stages in the dissection of this specimen.

Right side. The right kidney was moderately lobulated, the hilus widely open and directed anteriorly (Fig. 1). The organ rested chiefly upon the psoas major muscle, extending from the level of the lower third of the second, to that of the middle of the fifth, lumbar vertebra; its upper two-thirds was therefore abdominal in position, its lower one-third pelvic. The inferior extremity covered the lumboinguinal nerve; the lateral femoral cutaneous nerve emerged from the lateral margin of the psoas major muscle at the point to which the muscle was covered by the kidney; skirting the lateral margin, at the superior pole, was the combined trunk of the iliohypogastric and ilio-inguinal. The ureter entered the broad hilus in two portions; the lower was exposed as it divided into major calyces, while the upper was concealed by the renal veins.

The upper portion of the kidney was supplied by a renal branch of the aorta which arose at the level of the lower third of the first lumbar vertebra (Figs. 1 and 2). Follow-

From the Department of Anatomy and the Department of Urology, Northwestern University Medical School; contribution No. 281 from the former.

[1]However, the recorded incidence of ectopic kidneys noted in clinical examinations is considerably lower: Thomas and Barton 6 in 3,285 urological examinations, Thompson and Pace 1 in 10,000 admissions at the Mayo Clinic, MacKenzie and Hawthorne 13 in 15,000 examinations. Thompson and Pace suggest the discrepancy between necropsy and clinical examination was due to the fact that many ectopic kidneys were asymptomatic, special examination not indicated, and they were not diagnosed. They point out that in 52 of 88 clinical cases the diagnosis was established during the course of the urological examinations, including pyelographic studies; in the other 36, the diagnosis was made at the time of surgical exploration. An uninfected ectopic kidney with adequate urinary drainage frequently remains asymptomatic and may be discovered only during the course of an operation or at necropsy.



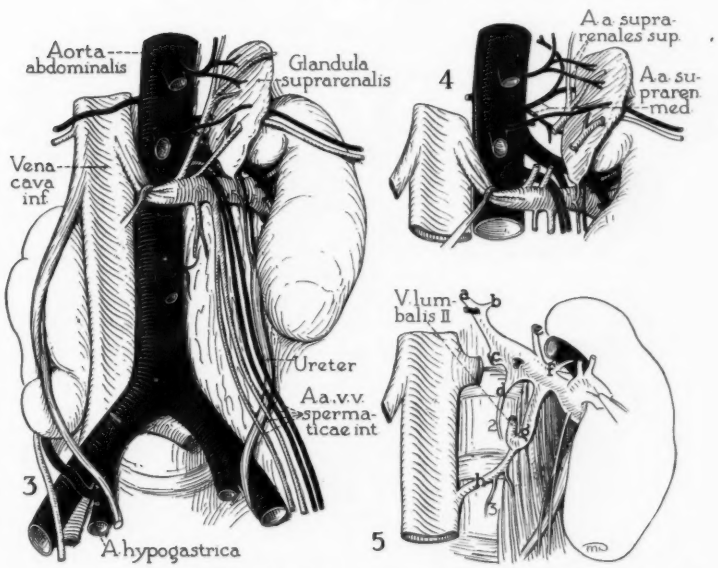
Figs. 1, 2, and 2a. Posterior abdominal and pelvic structures, especially of the right half of the body. Anterior, and slightly lateral views. Three-eighths natural size.

Fig. 1. The arteries and veins of the anomalous kidney, of the suprarenal gland and testes, with the principal structures related to the two organs. The kidney rests upon the quadratus lumborum, psoas major, and iliacus muscles. Left crus of diaphragm cut; liver totally removed, the hepatic tributaries of the vena cava transected. The hypogastric origin of the anomalous renal artery is not in view.

Fig. 2. The structures in the immediate area of the right kidney. The inferior vena cava has been cut and turned forward to show the two renal and a parietal vein, and the two sets of suprarenal arteries.

Fig. 2a. The anomalous kidney excised, the veins retracted to reveal the arrangement of vessels and of ureter within the anteriorly placed hilus. The internal spermatic vein removed to show its sulcus.

ing an oblique course downward and lateralward, it appeared from beneath the inferior vena cava where the latter received the right renal vein. The artery divided into three branches; two of these pierced the renal substance on the floor of a sulcus which was continuous with the widened hilus (Figs. 2 and 2a); the backward-directed stem entered the parenchyma behind the superior extension of the hilus (Fig. 2a). The anterior one of the hilar branches gave off several twigs to the upper extremity (shown by retracting the vessel in Fig. 2a), then disappeared by passing between the tributaries of the adjacent vein; the posterior hilar branch, passing behind the superior vein, coursed downward along the



Figs. 3 to 5. Posterior abdominal and pelvic structures, especially of the left half of the body. Three-eighths natural size.

Fig. 3. The arteries and veins of the kidney, suprarenal gland and testes; the left renal vein has been drawn inferiorly to show more clearly the constituents of the renal pedicle.

Fig. 4. The suprarenal veins have been transected, the gland lifted superiorly, in order to show the origin and course of the renal, suprarenal, and spermatic arteries.

Fig. 5. The aorta has been excised, the renal vein transected and turned aside to show the prevertebral venous plexus and its relation to the second lumbar vein.

medial margin of the hilus. The lower portion of the kidney was supplied by an arterial branch derived from the hypogastric close to its origin (Figs. 1 and 3); turning upward, and crossing the external iliac artery and the psoas major muscle, it pierced the lowermost portion of the inferior extremity, within a sulcus (1 centimeter in depth), continued downward from the hilus.

From the upper portion of the hilus a renal vein left the kidney (Fig. 1); it was formed by the junction of two vessels which emerged from the parenchyma (Figs. 2 and 2a). Into the inferior one of the two tributaries the right internal spermatic vein passed. The renal venous tributaries, in the hilus, passed to either side of the more anteriorly placed branch of the renal artery (drawn apart in Fig. 2a). The anterior one of the two vessels drained chiefly the lower part of the kidney, while the posterior one carried blood mainly from the upper portion. Veins were situated in front of, between, and behind the subdivisions of the ureter.

The right renal veins did not communicate with the ascending lumbar vein of the corresponding side; however, the lumbar system did form an anastomosis with the peri-aortic ring contributed by the renal veins of the left side.

The right ascending lumbar vein began as a tributary to the common iliac vein (Fig. 7). As it passed the fifth lumbar vertebra no lumbar vein was sent medialward to the inferior vena cava, but tributaries were received at this point from the vertebral canal. A small fourth lumbar vein was present. At the third segment a lumbar vein of fair size connected the ascending lumbar system with the inferior vena cava. Between the third and second segments the ascending lumbar vein was small, but opposite the second vertebra,

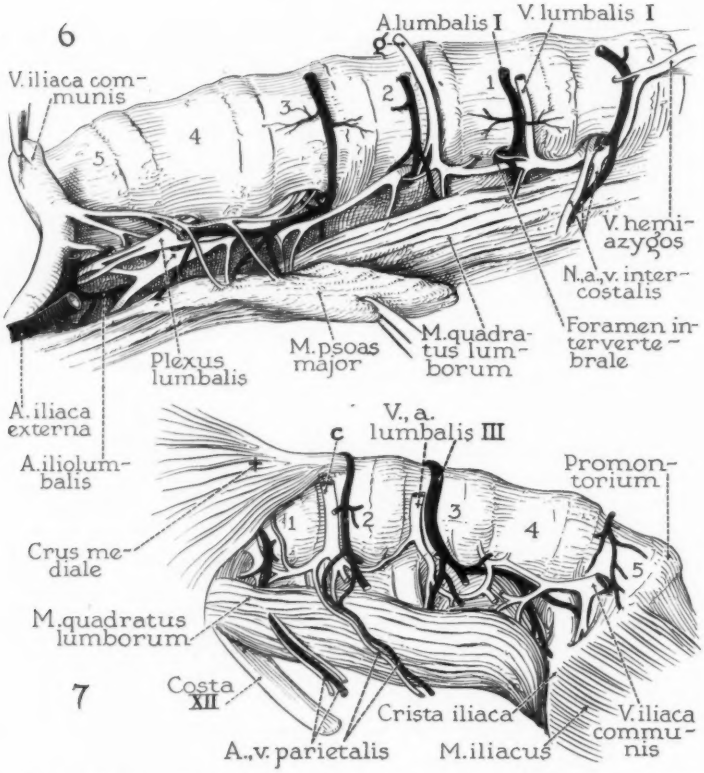


Fig. 6. The ascending lumbar vein and related structures of the left side; the psoas major muscle has been freed and turned aside, the quadratus lumborum muscle is intact; the left crus of the diaphragm has been removed to display the communication of the lumbar with the azygos system of veins. The second lumbar vein, here indicated by arrow, is the vessel (shown in Fig. 5) which communicated with the circumaortic ring.

Fig. 7. The ascending lumbar vein and the lumbar arteries of the right side, with related structures: the crus of the diaphragm partially covers the first lumbar vertebra; the quadratus lumborum muscle (the psoas major removed); the iliac muscle below the brim of the greater pelvis. The lumbar plexus of nerves has been removed.

the lumbar vein again enlarged; in addition to tributaries from the psoas major muscle and the vertebral plexus, two tributaries were received from the posterior abdominal wall. It was with the second lumbar vein that one of the tributaries of the retro-aortic venous plexus communicated. Continuing cranialward, the ascending lumbar vein passed beneath the crus and became continuous with the azygos vein in the thorax (Fig. 5).

The arrangement of the lumbar arteries was somewhat irregular. The fifth lumbar artery terminated in the fine twigs on the vertebra; the fourth was wanting; the third, the largest of the group, sent branches into the inferior three intervertebral foramina; the second and first supplied unusually prominent branches to the musculature of the back. No segmentally arranged branches of the aorta were sent to the kidney (Anson, Richardson, and Minear, 1936, Figs. *b* to *j*).

Left side. The left kidney was normal in form and in position (Fig. 3); its inferior extremity did not quite reach the level of the

crest of the ilium, extending from the middle of the twelfth thoracic to the lower third of the third lumbar vertebra.

The exposed course of the single renal artery was very short. It arose from the aorta opposite the upper third of the first lumbar vertebra; appearing from beneath the inferior extremity of the suprarenal gland, the artery quickly divided into two branches which entered the hilus of the kidney (Figs. 3 and 4). The single renal vein was a vessel of large size and transverse course; it crossed the aorta just beneath the origin of the superior mesenteric artery, at the level of the intervertebral fibrocartilage between the first and second lumbar vertebræ. It received on its cranial margin an inferior phrenic vein (which had suprarenal tributaries) and a suprarenal vein; just lateral to the suprarenal vein a pair of internal spermatic arteries arched over the renal vein. On its caudal margin the renal vein received an internal spermatic, formed by the junction of two tributaries; lastly, a small vein from preperitoneal tissue surrounding the aorta.

A prevertebral venous plexus occurred in association with the left renal vein (Fig. 5). The plexus, imbedded in the thin stratum of connective tissue which intervenes between the great vessels and the vertebral column, was so placed that its existence would not be suspected by the surgeon; yet, in a current study of the renal and suprarenal territory, it was found that a comparable set of intercommunications is of frequent occurrence.[1]

The plexus began superiorly in two small veins, one from each crus of the diaphragm (Fig. 5 *a* and *b*); at their junction they formed a hiatus for the passage of a branch of the first lumbar artery. Widening somewhat, this channel received on its inferior aspect a communicating vein from the ascending lumbar system of the opposite side. This communicating vein (second lumbar of the right side), and the anastomotic vessel from the plexus (Fig. 5 at *c*) together joined the inferior vena cava (Fig. 2, at *c*). Next, the retro-aortic plexus received a small parietal vein, of medial course, from the surrounding connective tissue (Fig. 5, *d*); then, superiorly, a vein from the left crus of the diaphragm (Fig. 5, *e*). Adjacent to this diaphragmatic vein were two small renal tributaries (Fig. 5, *f*), which, en route to the common venous channel from the superior part of the hilus, surrounded the renal artery. On the inferior aspect of the channel a large vein, the second lumbar, entered from the psoas major muscle (Fig. 5, *g*). The lumbar vein emerged from the vertebral margin of the left psoas major muscle opposite the middle of the second lumbar vertebra; its drainage was not only muscular, but meningeal and osseous as well (Fig. 6 *g*). In prevertebral position its shape was that of a letter J; from the lowermost part of its curve a communicating branch was sent obliquely downward and to the right to bring this post-aortic group of veins once more into connection with the inferior vena cava (Fig. 5, *h*); the latter anastomosis established at the level of the middle of the third lumbar vertebra. The venous vessels just described passed behind the aorta; the renal vein proper passed in front (Figs. 3 and 4); together they surrounded the aorta to form a circumaortic venous ring[1]. They communicated at a point 1 centimeter medial to the hilus of the left kidney.

The renal drainage on the left side was brought into communication with the ascending lumbar system by means of this lumbar vein (Fig. 6, at *g*). The ascending lumbar vein itself was divided into two portions one inferior, one superior to, the third lumbar vertebra (Fig. 6), the drainage passing inferiorly and superiorly from this line of division. The superior portion was, as already mentioned, related to the renal vein. The second lumbar vein passed deeply into the psoas major muscle, attaining the level of the roots of the transverse processes. At the foramen between the second and third lumbar vertebræ it received a meningeal tributary, and in that locality several muscular tributaries from the psoas major; from above, one lumbar vein entered the ascending lumbar; passing superiorly, it became the hemi-azygos.

[1] In a comprehensive study of the renal and suprarenal vessels by Anson, Pick, and Beaton, 128 cadavers have been examined to date; in 15 of these (11.7 per cent), the circumaortic ring occurs; not infrequently, and in a manner to be described in a subsequent publication, the deeper one of the transverse veins communicates with a prevertebral venous plexus, and with lumbar veins (Fig. 5). These features have been described and figured by Lejars (1888), recently by Odgers (1931), Fagarasanu (1938), and others.

Fig. 8. Right retrograde pyelogram showing the renal pelvis of bizarre form, the dilated minor calyces, and the short ureter.

The veins inferior to the level of the third lumbar segment drained caudalward and were not segmentally arranged; interrupted between the levels of the second and third lumbar vertebræ, the meningeal veins emerging from the lower lumbar vertebræ (third, fourth, fifth), formed a venous trunk into which passed also muscular tributaries from the psoas major muscle; the trunk emptied into the common iliac vein, into which latter also drained a second vein from the fifth lumbar level. The corresponding arteries were derived from two sources: the iliolumbar branch of the hypogastric (inferiorly), the third lumbar artery(superiorly); no segmental arteries occurred at the fourth and fifth.

From this description it should be clearly evident that the parietal and visceral venous channels are intimately related. Thus, beginning with the pelvic level, in the specimen described, the iliac veins received vessels from the pelvic organs, muscles, and skeleton; by means of the lumbar veins (Figs. 6 and 7), blood was brought to the inferior vena cava, not only from the lumbar skeleton and musculature but from the spinal cord and its meningeal investments; additionally these veins received parietal rami (Fig. 7) from the retroperitoneal connective tissue, and their major trunk, the ascending lumbar vein, communicated with the common iliac vein (Fig. 6). In the subphrenic region, the chief caval tributaries were, of course, received from the kidney; one of these passed anterior to the aorta (Fig. 4), the other posterior to that axial vessel (Fig. 5). The pre-aortic vessel drained not only the kidney; but also the testis, suprarenal gland, retroperitoneal tissue, and diaphragmatic musculature. The retro-aortic vein, through its plexiform arrangement of tributaries, drained the muscle constituting the crura of the diaphragm, the areolar tissue housing the great vessels, and the upper extremity of the kidney (by means of minute veins); it communicated directly with the ascending lumbar system by means of the second lumbar vein. Through the continuity of the lumbar with the azygos system (Fig. 6), communication was established between the pelvic, the abdominal parietes and contents, and the thoracic wall and serous membranes.

The importance of this anastomosis in the spread of infection through the entire renal and deep lumbar areas is obvious. The rich set of anastomoses may account for the spread in cases reported by other investigators. Thus Israel (1911) and Bavard (1921) noted that fatal tuberculous meningitis may follow nephrectomy for tuberculosis. Another fatal case was recently reported by Turner, death occurring 36 days postoperatively. Autopsy revealed no tubercular foci in the nephrectomy area. In the presence of rich venous anastomoses direct intrameningeal contamination could easily occur as the result of renal manipulation incidental to nephrectomy.

SURGICAL SPECIMEN

An ectopic kidney is subject to all the diseases which may assail a normal kidney; in addition, as a result of its anomalous development, aberrant vessels, constrictions, and adhesions may predispose to malfunction and pathological changes. When urinary drainage

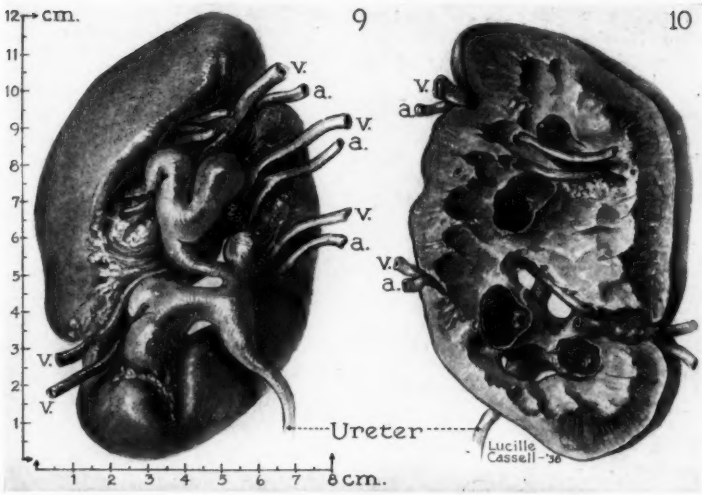


Fig. 9. Excised right kidney (same as Fig. 8) with anterior pelvis (injected with wax). Showing the bifid pelvis, the numerous hilar arteries and veins which course along each side of the infundibula (see arrangement of the vessels in Fig. 1). Abbreviations: *a*, artery, *v*, vein.

Fig. 10. The dorsal half of the same kidney, showing on the cut surface, the cavitation at the minor calyces.

is incomplete, symptoms of indefinite low abdominal pain and backache occur, frequently accompanied by hydronephrosis, infection, or calculus.

When indicated, ectopic kidneys causing symptoms are preferably treated by nephrectomy. In 21 cases with ectopic kidney treated surgically, reported by Thompson and Pace, the kidney was removed in 17. MacKenzie and Hawthorne performed 7 nephrectomies and 1 exploratory operation for neoplasm in 13 cases. In Judd's series of 19 pelvic kidneys only 10 required surgery. Thomas treated his 6 ectopic kidneys surgically, presumably by nephrectomy.

In the present case, renal ectopia caused distressing vague abdominal pain and backache. Nephrectomy was necessary owing to the unusual relationship of the renal vessels to the infundibula.

C. J., female, aged 27 years, entered the Passavant Memorial Hospital January 31, 1936, complaining of vague right abdominal pain and backache associated with frequency, urgency, dysuria, and nocturia for 8 years. The appendix had been removed for the above complaint 2 years before. There was a history of measles, mumps, whooping cough, chicken pox, malaria, and scarletina during childhood. The general physical examination was essentially negative except for an asymptomatic scoliosis. Complete urological investigation revealed a low lying, fixed, uninfected right kidney with good function. Right retrograde pyelogram (Fig. 8)revealed a bifid pelvis, dilated minor calyces and a short ureter. The left kidney was thought to be normal. The bladder and urethra revealed a low-grade chronic infection. The bladder urine contained pus cells (grade ii), motile bacilli and motile trichomonas. The culture revealed bacillus coli. Under gas anesthesia on June 9, 1936, an extraperitoneal right nephrectomy was performed. The postoperative convalescence was uneventful and the patient experienced complete relief of pain in the right abdomen and back.

The surgical specimen (Figs. 9 and 10) measured 7 by 12 centimeters. The kidney was unusually flat and oval in shape; the renal pelvis was bifid and anteriorly placed, the hilus open and unobstructed. There were 4 separate arteries and veins. Surfaces made by cutting exposed the dilated minor calyces, appearing as cavities measuring 1 to 2 centimeters in diameter. In the anomalous pedicle, due to early division of the arteries and veins, the vessels surrounded and passed close to the infundibula as they emerged from the renal parenchyma. This vascular arrangement produced a "vise-like" constriction sufficient to produce the intrarenal hydronephrosis. Two veins entered the lateral margins of the kidney;

although their origin was not identified at the time of operation, it is reasonable to suppose that they were related to either iliac or hypogastric veins (see arteries, Figs. 1 and 3).

The authors are indebted to Earl W. Cauldwell and Hugh Wilson for the careful preparation of the anatomical dissections.

REFERENCES

1. Anson, B. J., Richardson, G. A., and Minear, W. L. Variations in the number and arrangement of the renal vessels. J. Urol., 1936, 36: 211–219.
2. Bavard, Andre. Theses médicales, Lyon, 1920 and 1921, 53: 201–210.
3. Boylston, G. A., and Anson, B. J. Pelvic kidney and renal vessels in a newborn child. J. Urol., in press.
4. Braasch, W. F. The clinical diagnosis of congenital anomaly in the kidney and ureter. Tr. Am. Ass. Genito-Urin. Surg., 1931, 8: 381–392.
5. Campbell, M. F. Renal ectopy. J. Urol., 1930, 24: 187–198.
6. Fagarasanu, I. Recherches anatomiques sur la veine rénale gauche et ses collaterales. Ann. d'anat. path. et norm. méd.-chir., 1938, 15: 9–52.
7. Israel, J. Die Endresultate der Nejohrektomieen bei Nieren tuberkulose. Folia urolog., 1911, 6: 257–286.
8. Judd, E. S., and Harrington, S. W. Ectopic or pelvic kidney. Surg., Gynec. & Obst., 1919, 28: 446–451.
9. Lejars. Les voies de sureté de la veine rénale. Bull. Soc. anat. de Par., 1888, 2 (5 ser.): 504–511.
10. MacKenzie, D. W., and Hawthorne, A. B. The ectopic kidney. Tr. West. Branch Am. Urol. Ass., 1937, 6: 13–20.
11. Odgers, P. N. B. Circum-aortic venous rings. J. Anat., 1931, 66 (pt. 1): 98–99.
12. Thomas, G. J., and Barton, J. C. Ectopic pelvic kidney. J. Am. M. Ass., 1936, 106: 197–199.
13. Thompson, G. J., and Pace, J. M. Ectopic kidney. Surg., Gynec. & Obst., 1937, 64: 935–943.
14. Turner, J. H. Meningitis following nephrectomy for tuberculosis; case report and review of the literature. J. Urol., 1935, 34: 216–221.

PRIMARY RETICULUM CELL SARCOMA OF BONE

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THE type of primary bone tumor to be described in this paper apparently constitutes a definite group which has not been recognized in the past. No provision for this group has been made in the classification of the Registry of Bone Sarcoma of the American College of Surgeons. In the Registry cases included in this present study the diagnosis of primary reticulum cell sarcoma was first suggested in 1931 (Registry No. 1059). It was not until 1936 that an initial diagnosis of primary reticulum cell sarcoma was made (Registry No. 1992). Prior to this date these cases had been variously classified as Ewing's sarcoma, Hodgkin's disease, lymphosarcoma, osteogenic sarcoma, leucosarcoma, or as inflammation. In view of these facts it seems worth while to emphasize the characteristics of this type of bone tumor and describe its clinical course, especially as this neoplasm seems to have a more favorable course than its appearance would indicate.

From our own material and from the Registry of Bone Sarcoma, we have collected 17 cases of primary reticulum cell sarcoma of bone. Of these, 10 were male, 7 female. The age distribution differs materially from that of the generalized form of reticulum cell sarcoma, which is primarily a disease of middle and old age—84.5 per cent of all cases occurring after the age of 40 and less than 1 per cent being found under 20 years of age. As will be seen from Table I, 77 per cent of the primary reticulum cell sarcomas of bone occurred under the age of 40 and 35 per cent under the age of 20.

In the generalized form of the disease, metastatic bone lesions occur most commonly in the vertebræ and skull. In sharp contrast, primary reticulum cell sarcoma of bone is found to be present most frequently in the long or flat bones (Table II).

From the Thorndike Memorial Laboratory; the Second and Fourth Medical Services (Harvard); the Mallory Institute of Pathology, Boston City Hospital; the Department of Medicine, Harvard Medical School, Boston; the Collis P. Huntington Memorial Hospital, Harvard, and the Pondville Hospital, Wrentham.

Clinically, the onset is similar to that of other primary bone sarcomas, namely, with pain not relieved by rest. Pain localized at the site of disease or referred to the joint nearest the tumor was the first symptom in 13 cases; in 3, a pathological fracture brought the patient to the physician; in 1, a painless swelling of the bone and surrounding soft parts was the chief initial complaint. An obvious and tender swelling of the affected part was noted in 8 instances. The general health of the patient was good in all but 2 cases; in these there had been considerable loss of weight and strength. In none was fever noted; in no instance were abnormalities found in the peripheral blood picture. The few blood calcium and phosphatase determinations which were done were within normal limits, but the number of determinations were too few to be significant. A history of injury preceded the initial symptoms in 5 cases, but we have no good evidence that trauma is actually of etiological importance. It is more probable that a minor injury brought on symptoms in an already diseased bone or that a previous injury was recollected by the patient when symptoms of importance supervened. Perhaps the most important clinical feature is that an extensive, painful, destructive process in a long bone is found in a patient whose general condition is good. In no other bone sarcoma is the contrast between the comparative well-being of the patient and the size of the lesion so marked.

TABLE I.—AGE DISTRIBUTION OF PRIMARY RETICULUM CELL SARCOMA OF BONE

Age	No. cases	Age	No. cases
0–9	0	30–39	4
10–19	6	40–49	2
20–29	3	50–59	2

TABLE II.—BONE INVOLVED IN PRIMARY RETICULUM CELL SARCOMA OF BONE

Location	No. cases	Location	No. cases
Femur	5	Humerus	3
Clavicle	4	Scapula	1
Tibia	3	Mandible	1

Fig. 1. Fig. 2. Fig. 3.

Fig. 1. Registry Case No. 1992. Roentgenogram of femur.
Fig. 2. Registry Case No. 1909. Roentgenogram of tibia.
Fig. 3. Registry Case No. 83. Roentgenogram of humerus.

Fig. 4. Registry Case No. 564. Roentgenogram of humerus.

In no other bone tumor may the lesion be so extensive and at the same time be so amenable to appropriate treatment.

The disease had existed, as suggested by the symptoms, for many months in several cases before the services of a physician were sought. In 7 cases, symptoms had been present for a year or more before treatment, and yet 5 of these patients are alive and apparently well from 3 to 14 years later. This very fact attests the comparatively benign nature of what appears roentgenographically, clinically, and histologically to be a highly malignant tumor.

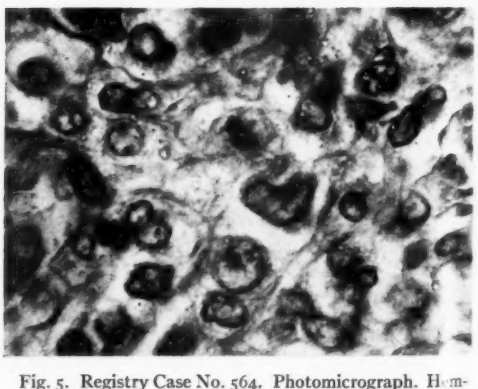

Fig. 5. Registry Case No. 564. Photomicrograph. Hematoxylin-eosin stain. × 927.

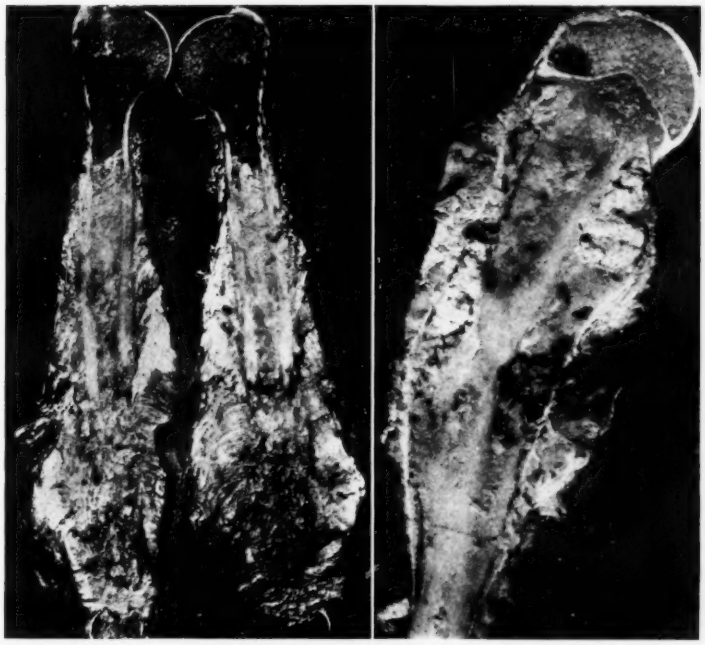

Fig. 6, left. Registry Case No. 564. Gross specimen, humerus.
Fig. 7. Registry Case No. 83. Gross specimen, humerus.

We wish, however, to emphasize the importance of early diagnosis and treatment; for by these means only can one expect to obtain the best results. In 1 instance, signs and symptoms definitely pointing to a tumor of the femur had been present for a year and 4 months before amputation, and the condition had been variously diagnosed as tuberculosis and as arthritis. At the time of operation, the tumor had reached massive size and inguinal lymph nodes had appeared. The patient was dead 3 months later. It is not improbable that, had an accurate diagnosis been made by biopsy at an earlier date, the results would have been better.

The x-ray appearance is by no means pathognomonic. The disease is most frequently seen in the ends of the long bones and extends from the metaphysis into the diaphysis (Figs. 1 to 4). In 3 cases the middle of the clavicle was the site of the tumor; in 1 the middle of the mandible was the point of origin.

In general, x-ray examination shows chiefly bone destruction, and to a much less degree new bone formation, sometimes incident to a pathological fracture. In early cases there may be only mottled bone destruction in the medulla (Figs. 1 and 2). In 1 early case, very fine striations extended from the irregularly thickened cortex and periosteum into the adjacent soft tissue. In the more advanced cases, there is extensive involvement of bone with marked osteolysis and only moderate or no osteogenesis (Fig. 3). Pathological fracture (Fig. 4) occurs occasionally and in those cases callus formation may complicate the picture. There is often fragmentation of the cortex and a widening of the shaft as if from an expansive tumor pressing from within outward. Periosteal thickening may be seen both early and late. Invasion of surrounding muscle is common. The disease has been mistaken by radiologists for osteomyelitis, osteogenic sarcoma, Ewing's tumor, and Hodgkin's disease.

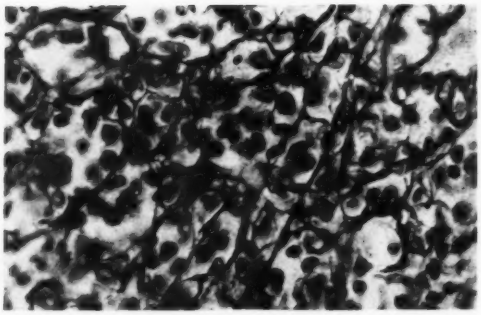

Fig. 8. Registry Case No. 1762. Reticulum stained by Foot-Hortega silver method. × 283.

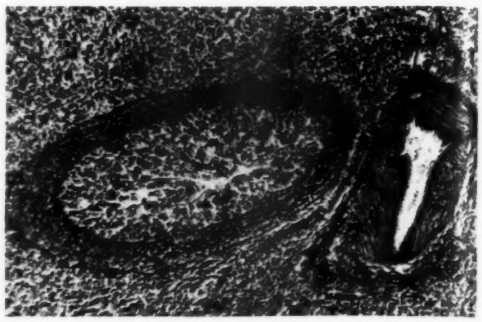

Fig. 9. Registry Case No. 1762. Tumor growing in vein. Wright elastic tissue stain. × 57.

In gross appearance, the tumor varies considerably. In early cases the medullary cavity is seen to be invaded by pinkish-gray granular tissue. In more advanced cases, the bone destruction and soft tissue involvement referred to elsewhere is obvious. The tumor in these instances is usually firm, smooth, and glistening; more rarely it is soft and friable. The color is variously described as pale, white, pinkish-gray, and gray-white. Areas of necrosis are frequent and may merge into cavities resembling osteomyelitis.

The type cell (Fig. 5) is identical with that of reticulum cell sarcoma of lymph nodes and other tissues. The nature of this cell and the histogenesis of reticulum cell sarcoma in general will be taken up in a subsequent paper. The cell is larger than a lymphocyte. The nucleus, which is from 1½ to 2 times larger than that of a lymphocyte, varies in shape from round to oval; frequently it may be indented or lobulated. In the cells of well differentiated tumors, the chromatin is finely divided and scattered. In the more anaplastic, it tends to be coarser and nucleoli may be prominent. The cytoplasm varies in its staining reaction from acidophilic to basophilic and may be considerable in amount in relation to the nucleus. The cell varies from round to oval to elongated. Evidence of ameboid activity, as indicated by shape of cell and its nucleus, is frequently present and is indeed a characteristic feature. Binucleate forms occur, but true tumor giant cells do not. Mitotic figures are often present in large number.

The stroma varies in amount from delicate strands of collagen to dense bundles. When stained in order to bring out the reticulum, this is found to occur running in delicate threads and strands around groups of tumor cells and also between individual cells (Fig. 8).

A fairly common feature of these tumors is the growth of the cells in the walls of small veins (Fig. 9). In such veins, the endothelium is lifted and the lumen is encroached upon and distorted by the tumor cells in the intima. A similar involvement of arteries or arterioles has not been seen. Necrosis of the infarct type is often a prominent feature. Scattered foci of lymphocytes are frequently found to be present.

Complete destruction and obliteration of the normal constituents of the marrow is constantly found. Osteolysis is often a prominent feature. The tumor cells do not form bone, but new bone formation by the stroma does occur. Invasion of the surrounding soft parts is common.

Reticulum cell sarcoma must be differentiated from the following conditions:

Hodgkin's disease. The granulomatous form with sclerosis, necrosis, eosinophils, and Reed-Sternberg cells should present no difficulty. The sarcomatous form in which the majority of the cells are of the mononuclear type may simulate closely anaplastic reticulum cell sarcoma, but the presence of even an occasional typical Reed-Sternberg cell should serve as a differential point. Primary Hodgkin's disease of bone we believe to be very rare indeed.

Lymphosarcoma. The type cell with its round nucleus, scanty cytoplasm, and spherical shape should offer no difficulty. In our experience, true lymphosarcoma of bone is extremely uncommon.

Ewing's sarcoma. Reticulum cell sarcomas have been most frequently erroneously diagnosed as Ewing's sarcoma. In the latter, the uniform character of the cells and of their nuclei, the arrangement in strands and cords, and the distribution of the reticulum are diagnostic features. In Ewing's sarcoma, the reticulum surrounds groups of cells, while in reticulum cell sarcoma not only does the reticulum surround groups, but it also runs between the individual cells.

Osteogenic sarcoma. Some of the reticulum cell sarcomas have been diagnosed as atypical osteogenic sarcomas. The lack of any tumor, bone, or cartilage formation, the absence of osteoid tissue, and the morphology of the tumor cells should serve to exclude this diagnosis.

Inflammation. The diagnosis of inflammation was made in 2 cases in the Registry. The presence of the large mononuclear cells and lymphocytes with, in addition, necrosis, have proved misleading. In one of our own cases, the infarct type of necrosis and marked cellular infiltration of the vessel walls led to the incorrect diagnosis of syphilis.

Since there have been no autopsies on the cases of reticulum cell sarcoma described, it might be argued that we are not justified in terming this group primary reticulum cell sarcoma of bone. However, the complete lack of evidence of a primary tumor elsewhere and the favorable course following amputation argues for the primary nature of this tumor. It is common knowledge that a small and, indeed, unrecognizable primary tumor, as in carcinoma of the breast or bronchus, may give rise to large metastatic lesions, but it would be most unusual to have a secondary lesion of massive size arise and still have the primary tumor remain silent 14 years after the amputation of the metastatic lesion, as in Registry Case No. 564. Furthermore, those patients who had inadequate treatment have shown evidence, before death, of metastases rather than the appearance of a primary tumor concealed, for a time, in an internal organ. Generalized lymph node and pulmonary metastases were found in one case. In another, a second tumor appeared in another long bone. In a third case, not included in the present series because we have only a lymph node biopsy (there had been a destructive lesion of the femur for 2 years prior to this biopsy), there appeared, before death, generalized lymphadenopathy, splenomegaly, hepatomegaly, and destructive lesions in the radius, humerus, and pubis.

The following cases illustrate the course of the disease.

W.B., a single man, aged 44 years (Bone Sarcoma Registry No. 564), was admitted to the Massachusetts General Hospital October 1, 1924. His past history was uneventful.

Since January, 1924, he had experienced moderate pain in the right upper arm. In May, 1924, while playing baseball, he fractured his right humerus. An x-ray film taken at this time showed no evidence of tumor. The bone, however, did not unite well and in August, 1924, the patient noticed a swelling of the middle of the right upper arm. Although the pain decreased, the tumor increased in size. An x-ray examination on October 2, 1924, showed destruction of the humerus throughout nearly its entire extent (Fig. 4). There was little if any new bone formation although there had been 6 months before a fracture in the midportion. The new-growth extended nearly to the head of the humerus. The proximal portion of the ulna appeared to be involved by a similar process.

On October 9, 1924, a shoulder joint amputation was performed. In 1924, this tumor was diagnosed as medullary sarcoma and as osteolytic sarcoma. In 1925, a diagnosis of osteogenic sarcoma was made, and in 1930 the condition was believed by one reviewer to be a benign giant cell tumor. In 1934, it was first suggested that the tumor was a reticulum cell sarcoma, the diagnosis being based on the criteria set forth in this paper.

Convalescence was uneventful and the patient remained entirely well until October, 1931, when a tumor developed in the amputation scar. This mass was excised and showed the same histological picture as did the original bone tumor. The patient has remained well and active to date, January, 1938, 14 years from the onset of symptoms.

That the disease was most extensive at the time of operation is attested by Figure 6, a photograph of the gross specimen removed in 1924.

W.S., a boy, aged 15 years (Registry No. 1663), aside from the usual childhood diseases, had been quite healthy. In the spring of 1927, he noticed a tender swelling in the region of the left knee. Radium was applied (in unknown doses) and the pain

and swelling completely receded for a period of 6 months. All symptoms then returned and the patient lost 30 pounds in weight. An x-ray examination on March 25, 1929, showed an irregular lesion involving the cortex and medulla of the proximal third of the shaft of the tibia. The lesion was mottled in appearance due to irregular zones of bone destruction intermingled with dense zones of new bone formation. The cortex was roughened and the periosteum lost in a large soft tissue swelling enveloping the knee. A diagnosis of Ewing's tumor was made and amputation was done March 26, 1929. This specimen was diagnosed in 1934 as Ewing's sarcoma, in 1936 as questionable reticulum cell sarcoma and as Ewing's tumor. In 1936, a definite diagnosis of reticulum cell sarcoma was made. Recovery was uneventful, and the patient is well and free from symptoms or signs of disease at present, 10 years after the onset of the tumor.

It is impossible at present to conclude what the best form of treatment is. Amputation followed by radiation to the adjacent lymph nodes, however, would appear to give the best results. In one instance (Registry Case No. 1523) excision appeared to be adequate, but we believe that amputation should be done whenever possible. In addition, radiation would seem advisable. A biopsy of the lesion may safely be done prior to amputation, but it should be emphasized that only by careful microscopic examination of a properly fixed and stained section can the correct diagnosis be made.

Three cases (Registry Nos. Sr., 1992, 1867) received radiation only. One of these died in less than 2 years with a massive hemorrhage from the original tumor. Two cases are still alive; in one (Registry No. 1992), the original tumor by x-ray examination seems to be essentially unaltered a year later; in the second (Registry No. 1867), a pathological fracture had just appeared in another long bone after 3 years.

Two cases (Registry Nos. 1663, 1723), had initial radiation with complete disappearance of both signs and symptoms, but, in each instance, the tumor recurred locally within 6 months. Amputation was then done and the patients are both alive and apparently free from disease 10 and 12 years from onset.

One case (Registry No. 1909) was given x-ray therapy for 5 years, but the symptoms steadily increased and lymph node metastases appeared. Amputation was then performed, and the patient is living and apparently well 14 years from onset.

In 6 cases, amputation was followed by x-ray therapy. In 4, radiation was given immediately after amputation. Three of these are alive and well respectively 8 months (Bu.), 8 years (Registry No. 1932), and 10 years (Registry No. 1059) from onset. The fourth patient (Registry No. 1951) died in 2 years of pulmonary and lymph node metastases after the amputation of a massive tumor of the femur which had been present for over a year and from which the inguinal lymph nodes had already become involved before operation. In another instance (Registry No. 547), excision of the tumor was followed 8 months later by a questionable metastasis in another long bone which was subjected to radiation therapy. The patient is alive and well 14 years later. In the sixth patient (Registry No. 564), a new neoplastic lesion appeared in the amputation scar after 7 years. This mass was excised and given radiation treatment as well. The patient is alive and well 14 years from the first symptom.

In 5 cases amputation only was done. Of these, 1 (Be.) died somewhat over a year later following a midthigh amputation for a lesion of the femur. A hip joint amputation would probably have been preferable. One patient (Registry No. 83) died 12 years from onset with a questionable metastasis in another long bone, no further follow-up having been made.

The 3 other cases (Registry Nos. 1762, 1523, M.C.) are alive from 3 to 12 years from onset. From a consideration of these data it would appear that amputation plus radiation offers the best chance of cure.

SUMMARY

Seventeen cases of primary reticulum cell sarcoma of bone are presented.

The disease may be seen at any age, usually occurs in the long or flat bones and, in spite of involving a given bone very extensively, usually leaves the patient in good general condition.

Roentgenographically, the lesion is primarily destructive, often massive. In the early stages, diffuse medullary mottling may be the only sign. Later, the expansive tumor may give rise to fragmentation of the cortex and pathological fracture.

Histologically, the tumor cells have round, oval, indented, or lobulated nuclei which are nearly twice the size of that of a lymphocyte. The chromatin is scattered and the cytoplasm is considerable in amount.

In spite of its apparently malignant nature, the tumor is amenable to appropriate treatment, 13 of the 17 cases being alive from 6 months to 14 years from the initial symptom. Seven of these patients have been apparently free from disease 10 or more years.

Five patients were treated by amputation alone. Of these, 2 are dead; 3 are alive from 3 to 11 years from onset. We have already referred to a possible explanation for the deaths in this group.

Three patients were treated by radiation alone. Of these 1 is dead; 2 are alive from 1 to 3 years later, but in each there is still neoplastic disease.

Of the 9 patients treated by amputation and radiation, 8 are alive from 6 months to 14 years from onset.

From a consideration of the cases presented, the best procedure would appear to be early diagnosis by biopsy followed by immediate amputation and radiation.

ABSTRACT OF CASE HISTORIES

Be., male, aged 31 years. In June, 1926, the patient sustained a minor injury to the knee. During the following summer there was gradually increasing pain and swelling of the knee. In October, 1926, an x-ray film showed a destructive lesion of the lower end of the femur with some periosteal thickening. In November, 1926, a biopsy was done and the following diagnoses were made: sarcoma, myeloma, syphilis, chronic inflammation. On December 17, 1926, a midthigh amputation was performed. The patient died September 10, 1927, with generalized lymph node metastases and metastases in the spinal canal and lung.

Sr., male, aged 35 years. In February, 1924, the patient felt something snap in his shoulder and he was incapacitated for a few days. In January, 1925, he felt another sharp pain in his left shoulder. Gradually swelling appeared over the left upper scapula. On April 1, 1925, an x-ray examination showed a destructive process in the scapula involving the spine and the acromial process. A diagnosis of osteomyelitis or sarcoma was made. Radium needles were inserted; the mass, however, continued to grow and the patient died October 24, 1925, following a massive hemorrhage from the original tumor.

Registry No. 1951, female, aged 48 years. In the spring of 1934, the patient noticed some stiffness in her left knee. In August of the same year, there developed considerable pain and swelling of the knee. In October, 1934, an aspiration biopsy was done and a tentative diagnosis of tuberculosis was made. By July, 1936, the pain had become much worse and the patient was put in a Thomas splint with traction. In January, 1936, there had developed an enormous swelling of the lower half of the thigh and enlarged inguinal lymph nodes. A hip joint amputation was done and a diagnosis of Ewing's tumor was made. X-ray therapy was instituted. The patient died April 26, 1936, with pulmonary and lymph node metastases.

Registry No. 83, female, aged 12 years. In February, 1920, the patient sustained a pathological fracture of the left humerus. Examination shortly thereafter showed a lobulated tumor of the upper half of the humerus. The mass was red, tender, and fluctuant. An x-ray examination showed a destructive process of the upper half of the left humerus and a pathological fracture. A shoulder joint amputation was done and a diagnosis of osteogenic sarcoma was made. The patient was lost sight of and died April 24, 1932, from a presumed "tumor of the right knee."

Bu., male, aged 14 years. H.H. No. 37-1599. In July, 1937, the patient sustained a mild injury to the right lower jaw. In September of the same year he noticed a painless lump in the middle of the right mandible. An x-ray examination showed an irregular increase of density of the right mandible and fine striations radiating into the surrounding soft tissues. On December 31, 1937, the right half of the mandible was resected and the patient given 1500 r units high voltage x-ray. The tumor was diagnosed as a reticulum cell sarcoma. The patient was alive and well March 7, 1938.

Registry No. 1992, female, aged 15 years. In the winter of 1935–1936, the patient noticed an intermittent pain in her right knee with some limitation of motion of the knee. On August 4, 1936, the general physical examination was normal. There was some thickening over the lower end of the right femur with slight limitation of motion of the knee. An x-ray picture showed a mottled destruction in the lower 2 inches of the femur without expansion and with little if any periosteal reaction. From a biopsy specimen on July 31, 1936, a diagnosis of reticulum cell sarcoma was made. The patient was given high voltage x-ray with symptomatic relief. The x-ray picture, however, remained essentially the same. The patient's condition was essentially unchanged August 5, 1937.

Registry No. 1867, female, aged 58 years. In June, 1934, the patient noticed a pain in the left chest which finally localized in the left sternoclavicular joint. In February, 1935, a tumor appeared at the inner end of the left clavicle. On June 5, 1935, the general physical examination was normal. There was an egg-sized tumor of the inner end of the left clavicle. A biopsy was performed and the lesion was variously diagnosed as mixed cell osteogenic sarcoma

and reticulum cell sarcoma. An x-ray examination showed a pathological fracture of the clavicle, bone destruction, and expansive tumor. High voltage x-ray therapy was given with symptomatic relief. On August 4, 1937, there appeared a pathological fracture of the humerus apparently due to a metastatic tumor.

Registry No. 1762, male, aged 29 years. In the summer of 1933 the patient noticed transient pain in the left knee. In the winter of 1933–1934, the pain became worse. In April, 1934, the tibia was incised, and a diagnosis of osteomyelitis was made. A discharging sinus resulted, and in May, 1934, some gelatinous material was obtained from which a diagnosis of osteomyelitis was made. In September, 1934, a large fungating tumor at the upper end of the tibia appeared and a diagnosis of Ewing's sarcoma was made. Amputation was done on September 19, 1934, at junction of middle and lower thirds of femur. Patient alive and well in February, 1937.

M.C., female, aged 24 years. M.G.H. 33-2637. In December, 1932, the patient noticed slowly increasing pain in the right knee. In October, 1933, there was diffuse swelling in the lower third of the right femur. An x-ray picture showed thickening in the lower part of the femur with diffuse mottling of the medullary cavity and periosteal thickening. A midthigh amputation was done October 16, 1933. The patient was reported alive in March, 1938.

Registry No. 1059, female, aged 18 years. In June, 1927, the patient felt listless and had been losing some weight. There was a painful swelling of the left clavicle near the sternum. A physical examination showed a tumor of the inner end of the clavicle and a diagnosis of cyst was made. The clavicle was incised and the necrotic material removed. A diagnosis of osteomyelitis was made. On October 4, 1927, the microscopic sections of material removed were reviewed and a diagnosis of Ewing's sarcoma made. The clavicle then was completely excised. In 1930, this tumor was variously diagnosed as Ewing's sarcoma, atypical sarcoma, osteogenic sarcoma, and giant cell tumor. In 1931, a diagnosis of reticulum cell sarcoma and lymphoblastoma was made. In November, 1927, the patient was given x-ray therapy over the region of the clavicle and was reported alive and well August 28, 1937.

Registry No. 1663, male, aged 13 years. In March, 1927, the patient fell and bumped his knee. Following this there was pain, tenderness, and slight swelling in the left knee. During the summer of 1928, radium was applied with the improvement of symptoms and the disappearance of the swelling. The tumor, however, recurred and the patient lost 30 pounds in weight. On March 25, 1929, an x-ray film showed in the proximal two-thirds of the tibia an irregular lesion involving both the cortex and medulla. The periosteum was lost in a huge soft tissue mass. A diagnosis of Ewing's tumor was made. An amputation was done March 26, 1929, with an uneventful recovery and a return to normal weight. The patient was alive and well March 10, 1937.

Registry No. 1523, female, aged 58 years. On December 15, 1925, the patient fell and struck her right shoulder with resulting severe pain and swelling. An x-ray examination on January 11, 1926, showed a pathological fracture of the surgical neck of the right humerus with a destructive process of the upper third of the right humerus, an elevation of the periosteum, and some thickening of the surrounding soft tissues. On January 25, 1926, the upper third of the humerus was excised. This tumor has been variously diagnosed as undifferentiated sarcoma (1933), leucosarcoma (1933), reticulum cell sarcoma (1934), lymphoblastoma (1934), reticuloendothelioma (1934). The patient was alive and well September 21, 1937.

Registry No. 1723, male, aged 34 years. On August 8, 1925, the patient sustained a pathological fracture of the right clavicle. An x-ray picture showed a pathological fracture and a destructive lesion of the outer and middle thirds of the clavicle and a large soft tissue mass. X-ray therapy was given with the disappearance of the tumor and a union of the fracture. The tumor, however, recurred and on March 26, 1926, the clavicle was excised. This tumor was diagnosed as Ewing's sarcoma (1934), reticulum cell sarcoma (1935), and lymphoblastoma (1935). The patient was alive and well August 14, 1937.

Registry No. 1909, male, aged 26 years. In August, 1923, the patient noticed tenderness, edema, and heat over the upper tibia. A diagnosis of osteomyelitis was made. On June 28, 1930, a biopsy was done and a diagnosis of sarcoma made. High voltage x-ray was given but a lymph node appeared in the groin in November, 1931. This was excised December 4, 1931, and a diagnosis of lymphoblastoma made. X-ray therapy was continued, but the pain and tenderness increased and on August 16, 1935, a midthigh amputation was done. The patient was alive and well May 22, 1937.

Registry No. 564, male, aged 44 years. In January, 1924, the patient noticed pain in the right humerus. He was treated with ultraviolet light. In May, 1924, he fractured his right humerus while throwing a baseball. In August, 1924, the patient noticed a tumor of the lower end of the humerus, but no pain. On October 2, 1924, an x-ray examination showed a destructive tumor of the lower third of the humerus with a small amount of new bone formation and a pathological fracture. The growth extended nearly to the head of the bone and what appeared to be a similar process was seen in the head of the ulna. On October 9, 1924, a shoulder girdle amputation was done. This tumor has been variously diagnosed as medullary sarcoma and osteolytic osteogenic sarcoma (1924), benign giant cell tumor, and osteogenic sarcoma (1930), and reticulum cell sarcoma (1934). In October, 1931, a tumor appeared in the amputation scar. This was excised and given x-ray therapy. The patient was alive and well January 1, 1938.

Registry No. 547, male, aged 14 years. In May, 1922, he had some pain in the lower right arm. In

February, 1923, there appeared a swelling of the middle of the right clavicle. The patient lost 30 pounds in weight. On June 20, 1923, the clavicle was excised and x-ray therapy was given to that region. This tumor was diagnosed as Ewing's tumor (1925), endothelioma (1930), and reticulum cell sarcoma (1934). In February, 1924, he experienced some pain in the shaft of the ulna. An x-ray film showed a questionable lesion in the ulna. X-ray therapy was given. On April 28, 1936, the patient was found to be alive and well, having completely regained his weight.

Registry No. 1932, male, aged 36 years. In late January, 1930, the patient experienced considerable pain in the right hip with resulting limitation of motion on that side. April 3, 1930, the patient fell and fractured the neck of his right femur. The resulting pain and disability were sufficient to warrant a resection of the end of the femur. The specimen removed, B.C.H. S-30-1139, showed reticulum cell sarcoma. Following operation, the patient was given high voltage x-ray therapy for a period of 4 months. The patient was alive and well with no signs of recurrence in April, 1938.

A STUDY OF THE SUPERFICIAL VENOUS PATTERN IN PREGNANT AND NON-PREGNANT WOMEN BY INFRA-RED PHOTOGRAPHY

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THIS is one of a group of studies of various aspects of the circulation in pregnancy carried out at the Boston Lying-in Hospital under the Department of Obstetrics of Harvard Medical School. Our aim was to demonstrate visually, if possible, any changes occurring in the superficial venous pattern before, during, and following pregnancy, and to attempt to correlate these changes with other facts pertaining to the circulation in pregnancy. For comparison some observations were made on non-pregnant women.

Infra-red photography of the veins has been done for several years. Massopust (6, 7) has published some observations on the superficial venous pattern in pregnancy with photographs comparing the veins of a primipara and a multipara. He suggests that there are differences peculiar to primiparity or multiparity. He also states that "the gradual changes in the breasts indicate that a gradual preparation for lactation is taking place which reaches its maximum directly after delivery when the mammary glands are actively functioning." Our conclusion on the first point is directly opposed to his. In addition, we do not feel that such an explanation of the breast venous changes is complete.

Infra-red photography is fundamentally the same as ordinary photography, but a different region of the spectrum is used. This has been made possible by the development of negative material sensitive to wave lengths in the near infra-red, or from about 700 micromicrons to 1100 micromicrons, with maximum sensitivity at about 800 micromicrons. Plates or films which are sensitive to infra-red waves are also sensitive to visible light and ultra-violet waves and it is necessary to exclude these waves so that exposure may be made only to infra-red rays. Since the type of plate used for most of this study was insensitive to visible red this was most conveniently done by placing over the lens of the camera a filter which allowed only red and infra-red rays to pass. Any sort of camera may be used for infra-red photography for which infra-red sensitive films or plates are obtainable. A camera which is equipped with a ground glass focusing screen is the most convenient type.

The camera used for this study was a Graflex, series D, with a Zeiss tessar f 4.5 lens, using either plates or cut film, size 3¼ by 4¼ inches. The lights were two 500 watt tungsten projection bulbs in reflectors. Eastman infra-red sensitive plates type 1R were used for most of the work, but for the latter part a new type of plate called simply Eastman infra-red sensitive plate was used. A Wratten filter No. 25 was used with the type 1R plate. The new type of plate, however, is also sensitive to visible red rays and, since the No. 25 filter transmits these, a Wratten No. 87 filter, which is opaque to all wave lengths of visible light but transmits infra-red rays freely, was used instead. The new infra-red plate was slightly faster and somewhat less "contrasty" than the type 1R plate and required the use of printing paper of one grade higher contrast. This made no practical difference.

The range of sensitivity of infra-red sensitive plates extends to 1100 micromicrons with maximum sensitivity at 800 micromicrons. According to Hardy and Muschenheim the most penetrating infra-red wave length is 1200 micromicrons. A bright tungsten fila-

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ment produces waves of this length. The sensitivity of the negative emulsion therefore limits the possibilities of infra-red photography to some extent. According to the same authors 21 per cent of the total incident energy is reflected by the skin surface, 66 per cent penetrates the stratum corneum and 50 per cent penetrates to the subcutaneous tissue. Waves of 1200 micromicrons undergo complete extinction in 3 millimeters of dead tissue and in the opinion of these authors would undergo more rapid extinction in living tissue due to the effect of the blood. The indistinct or hazy appearance of the veins is due to the scattering of the waves in the tissues. This is similar to the scattering of visible light, especially in the violet and blue region, caused by atmospheric haze. For this reason fine detail cannot be expected of structures as deep as ½ millimeter. It is unlikely, according to Hardy and Muschenheim, that photography of structures deeper than 2 millimeters is possible by infra-red waves, even if the sensitivity of the plates is increased to include waves of 1200 micromicrons, due to the complete extinction of these waves at a depth of little more than 2 millimeters of tissue.

The veins appear in the pictures because there is less reflection of infra-red waves from the areas traversed by the veins than there is from the tissue between the veins. In other words, the veins absorb more of the waves than does the tissue lying between them.

METHOD

The subjects for this study included pregnant women from the prenatal clinic of the Boston Lying-in Hospital, normal non-pregnant women, women from the sterility clinic of the Free Hospital for Women in Brookline, Massachusetts, and 1 patient from the Free Hospital for Women with a large fibroid uterus. The pregnant subjects were photographed at intervals of 2 to 8 weeks throughout pregnancy, the last antepartum pictures being taken as near term as possible. Postpartum pictures were taken when the patients were allowed up, usually from the tenth to the fourteenth day, but in some cases at the eighteenth to the twenty-fourth day. Patients were also photographed at the postpartum clinic visit at about 6 weeks, and again several months later after the cessation of lactation. The normal non-pregnant women were photographed both during and between menstrual periods. The patients from the sterility clinic were photographed several times, in order to have control observations should any of them become pregnant. One of these patients did conceive as did 1 of the other group of non-pregnant women. The patient with the large abdominal tumor was photographed both before and after operation.

There were 35 pregnant women in the series, of whom 20 were primigravidæ and 15 multigravidæ. There was a total of 14 non-pregnant women. Six of the primigravidæ and 4 of the multigravidæ had organic heart disease. Of the patients with heart disease, 1 had a patent ductus arteriosus and 1 had coarctation of the aorta. The others all had rheumatic heart disease with mitral stenosis and insufficiency. Three of the primigravidæ and 1 of the multigravidæ developed toxemia. One woman was followed throughout her first and second pregnancies, 2 pictures being obtained between the 2 pregnancies. There were 2 cases of twins; both of these mothers developed toxemia. Three of the women were photographed before as well as during and after pregnancy. There were an albino and two negroes in the series. Several of the subjects were also being used for other studies of the circulation in pregnancy (8). These studies included serial determinations of blood volume, venous pressure, circulation time, red blood cell count, hemoglobin, hematocrit, and vital capacity. Several of the non-pregnant subjects were photographed at various phases of the menstrual cycle. In the case of the patient with the large fibroid the abdomen was enlarged to the size of a 6 months' pregnancy.

The regions photographed were the trunk anteriorly and posteriorly and, in a few cases, laterally, and the lower extremities anteriorly and posteriorly. An occasional ordinary panchromatic picture was taken for comparison. A few pictures were taken with the subject lying in bed immediately after delivery, but as it was impossible to obtain the same perspective it is difficult, if not impossible, to

compare these pictures with those taken in a standing position.

In photographing the subject the distance from the camera to the subject was adjusted so that the area to be photographed filled the negative. This distance therefore varied slightly with the size of the subject. The lights were placed 2 feet to each side of the camera and were directed so as to give as flat illumination as possible since the emphasizing of body contours was not desired. Exposures of 3 seconds at f 16 were made but if the subject was unsteady or could not control her breathing an exposure of 1/5 second at f 4.5 was used. For the occasional ordinary photograph made for purposes of comparison Wratten and Wainwright panchromatic plates were used with the same camera and lights. For these the exposure was 2 seconds at f 32.

OBSERVATIONS

In the study of the finished prints the following observations were made:

No changes occurred in the superficial veins of non-pregnant women during the menstrual cycle (Figures 1, a and b).

There was considerable individual variation among both pregnant and non-pregnant subjects. It was not possible to tell from an isolated picture whether or not the subject was pregnant since some of the non-pregnant subjects showed a more marked venous pattern than did some of the pregnant subjects. Compare Figures 1, 2, and 3 with Figures 4, d, and 6, e.

There were no demonstrable differences between the changes in the venous patterns of normal pregnant women and those of pregnant women with organic heart disease or toxemia.

There is an increase in the prominence of the veins of the breasts early in pregnancy, noticeable at the third week and very definite at the eighth week. At the time of the first noticeable increase in the veins there is also a noticeable increase in the size of the breasts. The increase in prominence of the veins of the breasts progresses to term and is maintained after delivery during lactation. This accompanies the increase in the breast size. After the cessation of lactation, with involution of the breasts, there is a diminution in the prominence of the veins (Figs. 4, 5, and 6).

There is an increased prominence of the abdominal venous pattern first noticeable at about the fifth month when there is obvious enlargement of the abdomen. This prominence of the abdominal venous pattern progresses parallel to the enlargement of the abdomen until delivery. There is an abrupt diminution or in some cases complete disappearance of the abdominal pattern after delivery (Figs. 4, 5, and 6).

It is not possible to state from the appearance of the veins whether or not the subject is a primigravida or a multigravida. Individual variations among primigravidæ or multigravidæ are as marked as the variations between primigravidæ and multigravidæ. Non-pregnant women may have more prominent venous patterns than pregnant women. Compare Figures 3 and 6, d.

Definite changes are limited to the venous pattern of the anterior trunk. Slight and inconstant changes or no changes at all were found on the posterior trunk or the anterior and posterior surfaces of the legs. The depth of the superficial veins of the posterior trunk precludes satisfactory pictures of them.

There is a marked dissimilarity of venous pattern among all the subjects photographed. The individual subjects among the illustrations show a wide variety of pattern.

EVALUATION OF STUDY

In the explanation of the changes noted in this study several factors must be considered. From the fact that there is no constant detectable change, and in most cases no change at all in the veins of the lower extremities as pregnancy advances, it seems unlikely that venous stasis is responsible, since one would expect stasis to be most marked in the veins of the legs, for, while the venous pressure in the upper extremities remains within normal limits during pregnancy (2), the femoral venous pressure has been shown to be definitely increased (1). Probably whether or not the superficial leg veins become distended depends considerably on the competence of their valves. Certainly the increase of varicosities during pregnancy is incontestable.

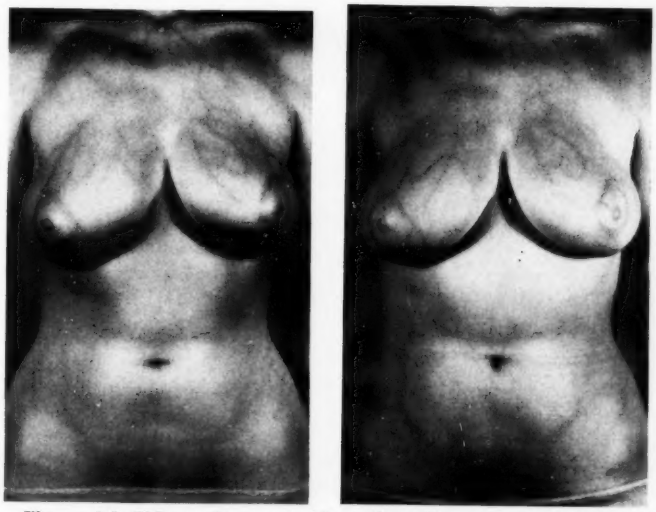


Fig. 1. a, left, H.R., aged 23 years, white, nulligravida, not pregnant. Infra-red photograph taken on third day of menstrual period. b, Same subject. Not menstruating. Infra-red photograph taken 20 days after beginning of last period.

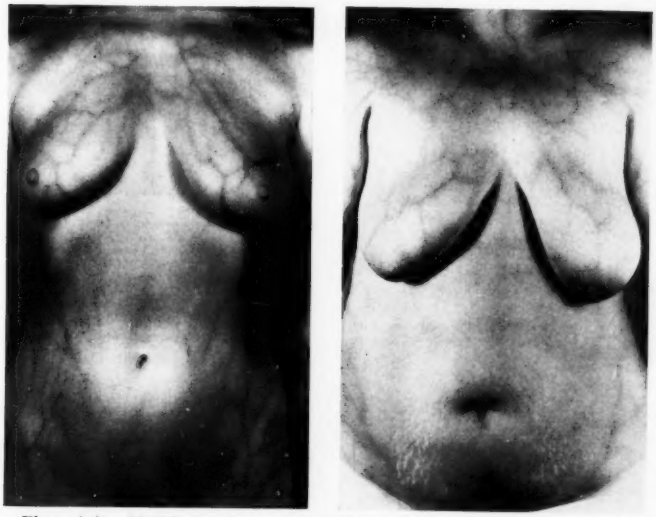


Fig. 2, left. M. M., aged 33 years, white, primipara, not pregnant. Only pregnancy occurred 7 years ago. Infra-red photograph taken on the fourth day of menstrual period.

Fig. 3. P. P., aged 25 years, white, nulligravida, not pregnant. Patient at sterility clinic of Free Hospital for Women. Infra-red photograph taken 25 days after beginning of last menstrual period.

It is within the realm of speculative possibility that hormonal or vasomotor changes accompanying pregnancy can effect dilatation of the veins. We have noted, for example during other studies in this clinic that the veins of pregnant women respond to vene-

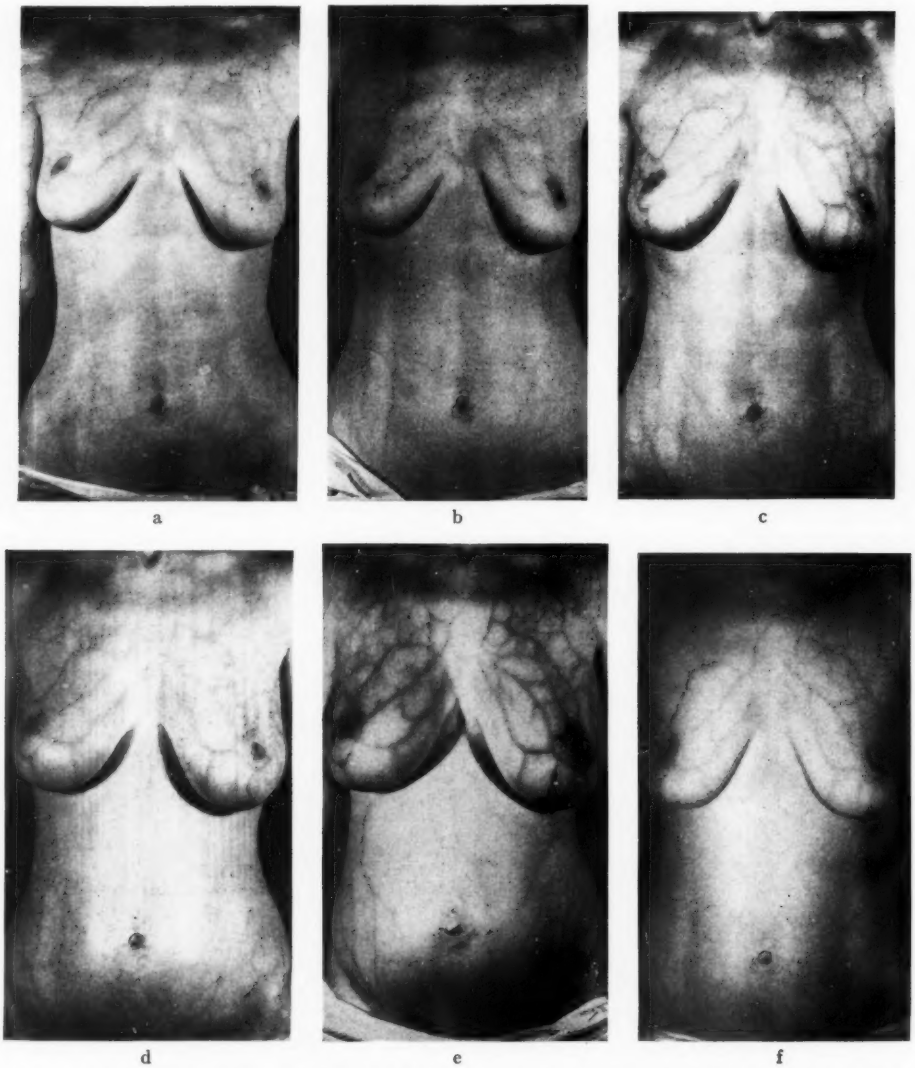
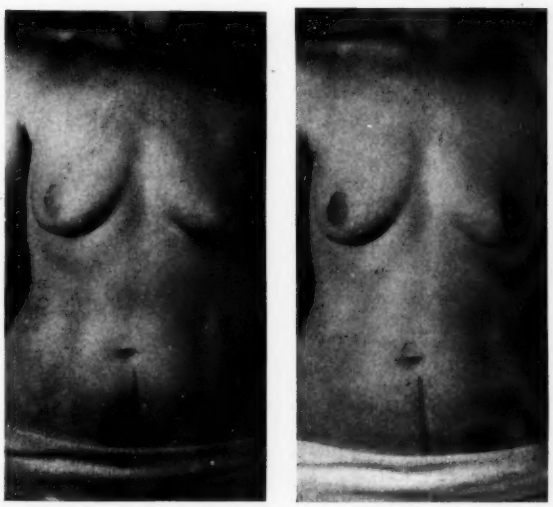


Fig. 4, a. F. T., aged 29 years, nulligravida, white, not pregnant. Patient at sterility clinic of Free Hospital for Women. Last menstrual period October 20, 1936. Infra-red photograph taken November 6, 1936. b, Same subject. Still not pregnant. Last menstrual period November 12, 1936. Infra-red photograph taken November 20, 1936. c, Same subject. About 3 weeks' pregnant. Last menstrual period December 6, 1936. Infra-red photograph taken January 8, 1937. d, Same subject. Eight weeks' pregnant. Infra-red photograph taken February 11, 1937. e, Same subject. Twenty-five weeks' pregnant. Infra-red photograph taken June 16, 1937. f, Same subject. Five and one-half months post partum. Infra-red photograph taken February 15, 1938.

puncture by collapse or constriction much more frequently than in the non-pregnant. If such an explanation were to account for the observed changes over the breasts and abdomen, it would disagree with the lack of such changes elsewhere.

a b c



d e

Fig. 5, a. K. C., aged 26 years, white, primigravida. Pregnancy complicated by rheumatic heart disease with mitral stenosis and insufficiency. Infra-red photograph taken June 4, 1936, 26 days before delivery by cesarean section, which was done at term. b, Same subject. Twenty-three days following section. Infra-red photograph taken July 23, 1936. c, Same subject. Forty-four days following section. Still lactating. Infra-red photograph taken August 14, 1936. d, Same subject. Seven months following section, 4 months following cessation of lactation. Infra-red photograph taken January 28, 1937. e, Same subject. Panchromatic photograph taken January 28, 1937, for comparison with Figure 5, d.

It is a common clinical impression that the veins in general, and particularly in the arms where they are most frequently observed, seem "fuller" during pregnancy, and we cannot disagree despite the failure of this study to provide graphic proof thereof. One would expect the venous blood content to increase, since the general circulating blood volume increases considerably (9). The cross section of a normal vein is an ellipse the long axis of which is parallel to the skin surface (3). Distention, therefore, would tend to produce a more circular cross section, which, while it would reduce the apparent diameter of a vein, would at the same time make the skinward surface more superficial. If, in addition,

Fig. 6.

the circumference of the vein alters in response to anatomical or functional changes in its wall, a third factor may be introduced. A photograph, of course, shows only two dimensional changes in the veins, and actual alterations may be present which remain undetected. The impression one has as he studies a series of pictures of the same subject showing the progressive increase of prominence of the veins to term is not so much that they appear to grow larger, but rather that they seem to become progressively blacker, more obvious, and less obscured by overlying tissue. After delivery and after lactation has ceased they

g

h

Fig. 6, a. C. M., aged 19 years, white, primigravida, first pregnancy ending in miscarriage at 5 months 1 year ago. Not pregnant at this time. Last menstrual period December 21, 1936. Infra-red photograph taken December 22, 1936, on second day of period. b, Same subject. Now about 4 weeks' pregnant. Infra-red photograph taken January 30, 1937. c, Same subject. Panchromatic photograph taken January 30, 1937. Note lack of venous detail. d, Same subject. About 8 weeks' pregnant. Infra-red photograph taken March 1, 1937. e, Same subject. Eleven weeks' pregnant. Infra-red photograph taken March 20, 1937. f, Same subject. Nineteen weeks' pregnant. Infra-red photograph taken May 15, 1937. g, Same subject. Thirty-four weeks' pregnant. Infra-red photograph taken August 28, 1937. h, Same subject. This infra-red photograph was taken February 12, 1938, 4½ months after delivery, when the patient was still lactating.

Fig. 7, a, left. S. S., aged 41 years, colored, nulligravida, not pregnant. Multiple leiomyomas of the uterus enlarging abdomen to the size of a 6 months' pregnancy. Infra-red photograph taken day before operation. b, Same subject. Infra-red photograph taken 2 weeks following hysterectomy.

appear to become again obscured by intervening tissue.

We believe that changes in the depth of the superficial veins over the abdomen and breasts play a large part in their photographic prominence during pregnancy and lactation. On the abdomen this is due to stretching of the skin by the protruding uterus, and, similarly, on the breasts by the increased volume of breast tissue. It will be noted that the appearance of prominent veins parallels the enlargement of the uterus and breasts. It appears likely that the large fibroid of the subject shown in Figure 7, a and b, was stretching the abdominal skin sufficiently to bring out the veins in the pre-operative picture. It is also probable that the breast and abdominal veins become prominent partly because of a relatively greater blood content than of veins elsewhere in the body. In the case of the breasts this may be attributed both to a functional increase of circulation and to some interference with venous return into the subclavian axillary system due to the effect of the heavier, more pendulous breasts, and in the case of the abdominal veins due to increased femoral venous pressure affecting the epigastric system.

An incidental observation made in this study was that the venous pattern of each subject differed from all the rest. It is suggested that this difference could be made the basis of a system of identification which might be a useful addition to such procedures. Alteration of the whole superficial venous pattern by surgery or by the injection of sclerosing substances would be a possible but a dangerous and painful procedure. The pattern of the superficial venous system should show almost as much variation as is found in the ridges of the fingertips.

CONCLUSIONS

1. Pregnancy is accompanied by definite, photographically demonstrable changes in the prominence of the superficial venous pattern of the anterior thorax and abdomen. Similar changes do not occur in the rest of the superficial venous system.

2. An isolated photograph of the veins gives no evidence as to whether or not the subject is pregnant, or as to her parity.

3. Similar changes do not occur as a result of the various phases of the menstrual cycle.

4. The changes in the prominence of the veins are principally due to the stretching and thinning of the overlying tissues. It is probable that an increase in blood content, and, in the case of the breasts, of physiological hyperemia contribute to the effect.

5. The same type of change occurs in pregnant women with organic heart disease or with toxemia as occurs in normal pregnant women.

6. The usefulness of the peripheral venous pattern as an aid to identification is suggested.

REFERENCES

1. Burwell, C. S. Am. J. M. Sc., 1938, 195: 1.
2. Cohen, M. E., Thomson, K. J. J. Clin. Invest., 1936, 15: 607.
3. Edwards, E. A. Anat. Record, 1936, 64: 369.
4. Hardy, J. D., and Muschenheim, C. J. J. Clin. Invest., 1936, 15: 1.
5. Helwich, Othmar. Practical Infra-red Photography. The Fountain Press, London.
6. Massopust, L. C. Surg., Gynec. & Obst., 1936, 63: 86.
7. Idem. Radiography & Clin., Photography, 1934, 10: 4.
8. Thomson, K. J. et al. (In press.)
9. Thomson, K. J., Hirsheimer, A., Gibson, J. G. II, Evans, W. A. Am. J. Obst. & Gynec., 1938, 36: 48.

STUDIES ON THE GROWTH STIMULATING EFFECT OF POTASSIUM NAPHTHALENE ACETATE AND POTASSIUM INDOLE BUTYRATE

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A SEARCH for growth promoting substances has led horticulturists to the discovery of so called phytohormones or auxins which stimulate growth by elongation of cells and their capacity of moving downward in the plants. Further studies showed that two closely related substances, named "auxin A" and "auxin B," were responsible for these effects. Later a third, entirely different substance, named "hetero-auxin," was found to produce the same effects (7). A substance called bios, indispensable for the development of yeast and discovered by Wildiers, is closely related to the vitamin B complex (13, 21). The discovery that several synthetic crystalline products cause growth responses in plants served as the basis for work in this field by Zimmerman and Wilcoxon (22, 23); they demonstrated the property to stimulate plant growth in not less than 53 chemical compounds. At the same time auxin was recovered from the human urine in crystalline form (8). Its genesis remains unknown although theoretically its production by intestinal bacteria, its origin from ingested vegetable foods, or its synthesis by the animal organism must be taken into consideration.

All these observations suggested studies of the effects of phytohormones on the animal organism, particularly so because growth promoting substances may find their application in the treatment of burns, indolent ulcers, etc. and also because their rôle in the origin of malignant tumors is within the range of possibility.

From the numerous compounds investigated by Zimmerman and Wilcoxon, two were chosen for the present study, viz., the potassium salts of naphthalene acetic and indole butyric acids, for the following reasons: Indole acids are closely related to tryptophane, i.e., are not strange to the animal organism; indole acetic acid can be recovered from the urine and the observation has been made that certain indole compounds occur in carcinomatous tissue in concentrations twice that of normal tissue (8). The naphthalene compounds spread readily causing systemic responses, whereas lanolin preparations of indole butyric compounds tend to induce a local response (22). Thus by the use of the potassium salts of naphthalene acetic and indole butyric acids, both the local and general effects of phytohormones could be investigated. Salts were used as they are less toxic in high concentrations than the same concentrations of the acids; salts are also more soluble in water than the acids (22).

The present phytopharmacological investigation was confined to the study of the effect of the two above mentioned synthetic chemical substances on mammalian general growth and local stimulation of regeneration of skin defects.

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EFFECTS OF POTASSIUM NAPHTHALENE ACETATE AND POTASSIUM INDOLE BUTYRATE ON GENERAL GROWTH

Interest in stimulation of the growth of the mammalian organism is great, as can be evidenced from the multitude of substances and methods used for this purpose; lactoflavin (6), theelin (2), Lu-Jung (11), glucose (10), organic phosphorus compounds (12), spaying (2, 4) may be mentioned as examples.

For each experiment 3 litter mates with approximately the same weight were used. One rat was injected with the potassium salt of naphthalene acetic acid, another with the same salt of indole butyric acid, the third served as control. The experiment was repeated 7 times so that 21 animals were used for this part of the study.

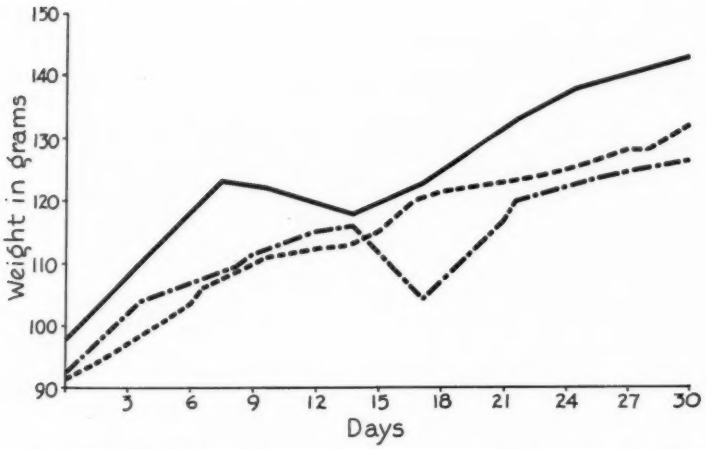

Chart 1. Sample weight chart. ——Control; —·—·—, potassium indole butyrate; - - - -, potassium naphthalene acetate.

To make the effect of the chemicals, if any, more noticeable, the rat with the greatest weight was selected as control, with the idea that the treated rats would catch up in weight with the control animal if the injected substance had a growth promoting effect. Only one reference as to dosage could be found in the literature, namely that of Anderson, Shimkin and Leake (1) who determined the acute intraperitoneal toxicity of some plant growth substances for mice and found that 100 milligrams of indole butyric acid and alphanaphthalene acetic acid per kilogram body weight kills half or more of the animals. Preliminary experiments by the writers showed that both compounds have a cumulative effect: 75 per cent of the calculated lethal dose was distributed over 10 successive days; all the animals died 3 to 7 days later. Apparently the compounds are at least as toxic for rats as for mice as the same dose per kilogram body weight proved to be fatal for rats in spite of the fact that not intraperitoneal but subcutaneous injections, with resulting slower absorption rate, were employed. In view of this fact, only 25 per cent of the lethal amount was used in the actual experiments; the total amount of 25 milligrams per kilogram body weight was divided into 10 doses, given on 10 successive days. The accompanying sample weight chart illustrates the results which were approximately the same in each of the 6 groups. The weight of the treated rats never reached the weight of the control animal; the latter gained in course of 30 days 45 grams or 45.91 per cent of the original weight; the rats which received injections of potassium naphthalene acetate gained only 40 grams or 43.47 per cent of the original weight; the corresponding figures for the rats which received injections of potassium indole butyrate were 35 grams or 35.48 per cent. Measurements of the body and tail length did not reveal any marked differences between the treated and untreated animals. Apparently both chemicals under discussion have no appreciable influence on the growth of young rats.

EFFECT OF POTASSIUM NAPHTHALENE ACETATE AND POTASSIUM INDOLE BUTYRATE ON LOCAL GROWTH

The fascinating study of regeneration is of great interest to the surgeon who is concerned chiefly with the reparative processes following traumatic or operative injuries of tissues. Innumerable methods and substances have been recommended for stimulation of granulations; among the newest the following may be mentioned: thyroid extract (3, 14), hypertonic wet dressings (19), thiocresol (15), allantoin (5,17),

Fig. 1. Photograph showing the appearance of symmetrical burns immediately after their production.

Fig. 2. Appearance of burns 18 days after their production. Left burn treated with petrolatum, right with potassium naphthalene acetate.

Fig. 3. Appearance of burns 18 days after their production. Left side treated with petrolatum, right with potassium indole butyrate.

urea (18), sulphydryl group (16) and cod liver oil (9).

The experiments reported here were confined to the effect of potassium naphthalene acetate and potassium indole butyrate on the healing of artificially produced skin defects. First, an attempt was made to excise approximately equally large portions of the skin from the dorsal region of rats on either side, one to serve as control and the other to be treated with local applications of the chemicals; it was discovered, however, that it is practically impossible to create with a scalpel or scissors skin defects of equal size.

A rectangular branding iron, 18 millimeters in diameter, was found to serve the purpose best; the duration of the application of the hot iron and the pressure applied to it were gauged so as to produce a burn of the entire thickness of the skin. The first application of the 5 per cent ointment of the compounds in a lanolin vaseline base was made approximately 15 minutes after the production of a burn; the following applications were repeated at daily intervals for 7 days. The accompanying photographs show that the treated areas were healed 16 days after the production of burns, whereas 22 to 28 days were required for epithelization of the untreated burns. In other words, the application of the ointments containing salts of indole butyric and naphthalene acetic acids

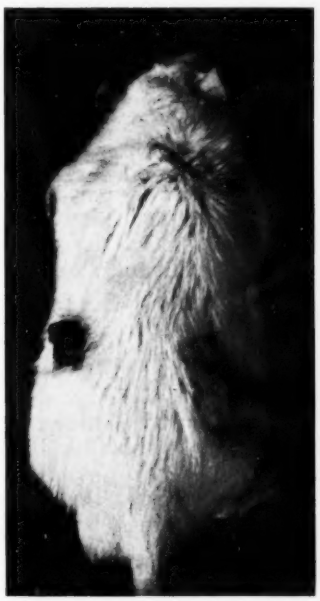

Fig. 4. Appearance of burns 18 days after their production. Left side treated with tannic acid, right with potassium indole butyrate.

shortened the healing period by about 35 per cent as compared with the time required in control lesions. Potassium indole butyrate accelerated the regeneration of the skin in a higher degree than potassium naphthalene acetate. The scab remained on the burns an equal time after the application of either salt, but when the scab was slightly lifted 8, 10, or 12 days after the production of the burn it could be seen that larger areas were covered with new epithelium when the first mentioned compound was used (Figs. 2 and 3).

For the sake of comparison in 6 rats the burns on the left side were treated with potassium naphthalene acetate and the burns on the right side of the same animals with a brilliant green jelly; the healing rate was approximately identical on both sides. In a similar experiment in which potassium indole butyrate was used, the healing time averaged 2 days less as compared with brilliant green.

In another series of experiments the right burns were treated with potassium naphthalene acetate or potassium indole butyrate respectively, while a 10 per cent tannic acid spray was applied to the left burns on 3 successive days (Fig. 4). The healing period was practically identical on the right side, no matter which compound was used. All the burns on the right side healed as an average in 18.3 days while 24.7 days were required for the healing of the burns treated with tannic acid. The observation was made that scabs formed over the burned areas treated with the potassium salts of either of the two chemicals studied were softer, more flexible, and not so firmly adherent to the subjacent tissues as those covering burns treated with tannic acid.

SUMMARY AND CONCLUSIONS

1. Under conditions used in this experiment potassium salts of naphthalene acetic acid and indole butyric acid had no effect on the general growth of young rats.

2. A marked stimulating effect of these two chemicals on the regeneration of burned skin was observed. The healing rate was more accelerated by the salt of the indole butyric acid than it was by the salt of the naphthalene acetic acid.

3. The local growth promoting effect of both chemicals was comparable to the effect of brilliant green jelly.

4. The local healing effect of both chemicals was much more pronounced than the effect of tannic acid.

5. More extensive investigations, including other animals in addition to rats, are desirable to appraise the therapeutic value of potassium naphthalene acetate and potassium indole butyrate in the treatment of burns and other skin defects.

The writers wish to express their sincere gratitude to Dr. George Wakerlin for his great help in carrying out this work.

BIBLIOGRAPHY

1. Anderson, H. K., Shimkin, M. B., and Leake, C. D. Proc. Soc. Exper. Biol. & Med., 1936, 34: 136.
2. Billeter, O. A. Am. J. Anat., 1937, 60: 367.
3. Cohen, M. H. J. Am. M. Ass., 1934, 102: 283.
4. Freudenberger, C. B., and Howard, P. M. Proc. Soc. Exper. Biol. & Med., 1937, 36: 144.
5. Greenbaum, F. R. Am. J. Surg., 1936, 34: 259.
6. Gyorgy, P. Proc. Soc. Exper. Biol. & Med., 1936, 35: 207.
7. Kogl, F., Haagen-Smit, A. J., and Erxleben, H. Ztschr. f. physiol. Chem., 1933, 220: 137.
8. Kogl, F., Haagen-Smit, A. J., and Tonnis, B. Ztschr. f. physiol. Chem., 1933, 220: 162.
9. Kuemmel, H. Deutsche Ztschr. f. Chir., 1936, 248: 238
10. Lafreshiere, G. Union méd. du Canada, 1936, 65: 104.
11. Mineshita, T. Folia Pharmac. Jap., 1937, 23: March 20.
12. Perichanjanz, J., and Sudzilowskaja, O. Arch. internat. de pharmacod., 1936, 54: 349.
13. Peters. Bio-Chem. J., 1928, 22: 445.
14. Puckett, H. L. U. S. Naval Med. Bull., 1935, 33: 510.
15. Reimann, S. P. J. Am. M. Ass., 1930, 94: 1369.
16. Reimann, S. P., and Hammett, F. S. Am. J. Cancer, 1935, 23: 343; 1936, 26: 554.
17. Robinson, W. J. Parasitol., 1935, 21: 354.
18. Idem. Am. J. Surg., 1936, 33: 192.
19. Taylor, F. W. Surg., Gynec. & Obst., 1935, 61: 623.
20. Wildiers. Cellule, 1901, 18: 313.
21. Williams, R. J. Am. Chem. Soc., 1927, 49: 227.
22. Zimmerman, P. W., and Hitchcock, A. E. Contrib. Boyce Thompson Inst., 1937, 8: 337.
23. Zimmerman, P. W., and Wilcoxon, F. Contrib. Boyce Thompson Inst., 1935, 7: 209.

BONE SARCOMA

Factors Influencing the Prognosis

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THE following is a report of the results of treatment of the 47 patients with primary malignant tumors of the long bones, excluding plasma cell myeloma, admitted to the surgical wards of the Massachusetts General Hospital during the 13 year period 1920 to 1932.

This series is a representative group of tumors of this character seen in a general hospital but the results of treatment should not be compared to those obtained in a children's hospital to which patients over 12 years of age are not admitted. It was felt that the figures as to the curability of bone sarcoma obtained by an analysis of the cases in the Registry of Bone Sarcoma of the American College of Surgeons would give an erroneous impression, for physicians are prone to report or register the successful cases and not the failures.

The cases here reported, with the exception of Case 48, have been registered with the Registry of Bone Sarcoma. The specimens from the cases of patients living 5 years have recently been reviewed by Drs. S. B. Wolbach and Tracy B. Mallory, pathologists, and by Dr. E. A. Codman in order to bring the pathological classification more closely in line with our present day knowledge.

No case is considered a cure unless the patient is living without evidence of disease 5 or more years since treatment. Three patients died of sarcoma more than 5 years from the date of operation (in 1 instance 12 years), and these cases are considered as failures.

The patients were all seen before it became the custom to study the blood chemistry. At present calcium, phosphorus, phosphatase, and serum protein determinations are made as a routine in all cases. Roentgenograms of the chest were taken before operation to exclude metastases as far as possible.

All of the 47 patients with sarcoma admitted to the hospital during the 13 year period have been followed to date (Table I).

TABLE I.—PRIMARY MALIGNANT BONE TUMORS

	Cases
Surgical treatment	37
X-ray treatment	6
No treatment	4
Total cases (all types)	47

Excluding the 4 cases who refused treatment, the 43 remaining may be divided into three main groups (Table II).

TABLE II.—SARCOMA, PATHOLOGICAL TYPES

	Cases
Osteogenic sarcoma	33
Ewing's sarcoma	8
Reticulum cell sarcoma	2

In reviewing the cases, the percentage of 5 year cures was found to be much larger than that usually reported, although it is unlikely that the surgical and radiation treatment is different in this institution from that obtaining in any comparable general hospital.

OSTEOGENIC SARCOMA

The largest group is that of the osteogenic sarcoma. Three died, without recurrence, of intercurrent disease within 5 years from the date of treatment and are excluded in determining the end-results. One of these died of acute appendicitis 2½ years after operation, 1 following an operation for acute cholecystitis 3½ years after operation, and 1 of a cardiac condition 2 years after operation. Excluding these 3 cases the results of treatment are shown in Table III.

TABLE III.—OSTEOGENIC SARCOMA—RESULTS

	Cases	Cures	Per cent
Surgical treatment	28	11	39
X-ray treatment	2	0	0

Fig. 1. Case 24. Osteogenic sarcoma fibrous type (Fig. 2). Female, aged 21 years. Symptoms for 1 month. Amputation. Well 6 years. The roentgenogram is atypical.

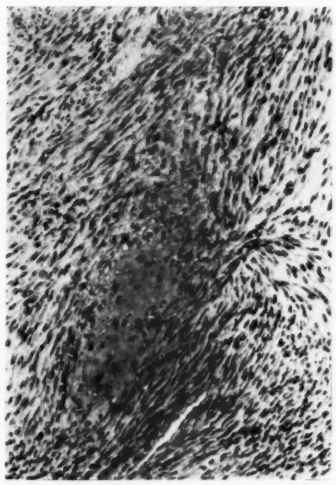

Fig. 2. Photomicrograph of specimen, Case 24. The specimen is composed chiefly of cellular fibrous tissue but shows areas of osteoid tissue, cartilage, and bone.

By surgical treatment amputation is meant, the entire affected bone being removed when this was possible. In tumors of the humerus, disarticulation at the shoulder joint was performed rather than shoulder girdle amputation. In tumors of the lower end of the femur, amputation was performed at the level of the lesser trochanter, but, if the shaft appeared to be involved, hip joint amputation was done. There was no operative mortality in this series.

Osteogenic sarcoma may be defined as a tumor originating from the embryonic fibroblast, which, under normal conditions, would differentiate into normal bone. The embryonic fibroblast may form fibrous tissue, cartilage, or osteoid tissue.

If we accept the idea just mentioned it is easy to account for the various forms of tissue, i.e., bone, osteoid tissue, cartilage, and adult fibrous tissue, found in the usual bone sarcoma. It was felt that the high percentage of cures obtained in this series might depend on a large proportion of the cases showing a high degree of differentiation of the cells; that is, if the major portion of the tumor was composed of adult tissue, cartilage, or bone, the tumor would prove to be less malignant than it would if composed of undifferentiated fibroblasts.

The cases of osteogenic sarcoma were therefore divided into three main groups which have been termed fibrous, chondral, and anaplastic. The tumors in all of the cases were histologically malignant, and in certain portions tumor giant cells and many cells undergoing mitosis could be found; but in the fibrous and chondral groups adult fibrous tissue or cartilage predominated. In the anaplastic group the greater portion of the tumor was composed of highly malignant cells.

Certain of the pathologists previously mentioned state that some of the cases I have placed in the fibrous and chondral groups probably should be placed in the anaplastic group, but the opinions as to which ones should be so placed varied. If the cases in which the patients were treated surgically are divided into the three types above mentioned, namely, fibrous, chondral, and anaplastic, the results of treatment are as shown in Table IV.

Fig. 3. Case 44. Osteogenic sarcoma tibia chondral type. Male, aged 18 years. Trauma 9 months. Tumor 6 months. Amputation. Well 10 years (Figs. 4 and 5).

TABLE IV.—OSTEOGENIC SARCOMA—RESULTS OF SURGICAL TREATMENT

	Cases	Cures	Per cent
Fibrous type	5	5	100
Chondral type	7	5	70
Anaplastic type	16	1	5.5

Fibrous type. There were 7 cases in this group. Five were treated by amputation and all 5 are living. The greater portion of the tumors was composed of relatively adult fibrous tissue. Two were treated by radiation and died of disease, one 6 and one 7 years after beginning treatment (Figs. 1 and 2). These 2 were cases of central sarcoma of the fibrous type erroneously diagnosed by x-ray as giant cell tumors. At first glance, the roentgenogram in the central type somewhat suggests a giant cell tumor. The growth is centrally placed, is bone destructive, and causes slight distention of the cortex, but

Fig. 4. Osteogenic sarcoma tibia chondral type, Case 44. Photograph of specimen (Figs. 3 and 5).

rarely extends to the joint cartilage. The longitudinal diameter of the defect is also usually greater than the transverse, which is not the case in giant cell tumor. Microscopically these tumors are composed of spindle cells with foreign body giant cells about the periphery where bone is being destroyed. The

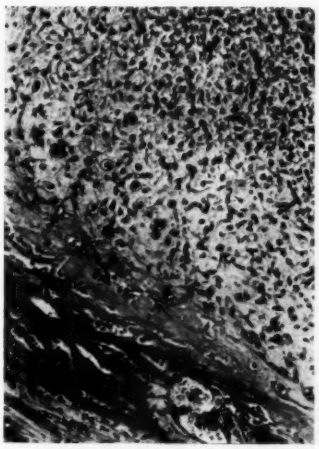

Fig. 5. Osteogenic sarcoma tibia chondral type. Photomicrograph of specimen, Case 44 (Figs. 3 and 4).

Fig. 6. Case 8. Osteogenic sarcoma. Anaplastic type (Figs. 7 and 8). Male, aged 17 years. Trauma, 1 year; pain, 4 months; tumor, 3 months; curetted, 2 months. Amputation. Well 8 years.

presence of a few foreign body giant cells may lead to the erroneous diagnosis of giant cell tumor unless this is borne in mind. That the central fibrous type of osteogenic sarcoma is of low malignancy or radiosensitive is suggested by the fact that the 2 patients treated by x-ray lived for several years before showing evidence of lung metastases. One of the cured cases in which amputation was done was of this character. I have seen another similar case, not in the series, in which amputation was performed, and the patient is living and well over 5 years after operation.

Five of the 7 were of less than 6 months' duration from the first symptom to the initiation of treatment, one 9 months, and one 12 months. In one of the cured cases the patient had been subjected to curettage under the

Fig. 7. Case 8. Photograph of specimen (Figs. 6 and 8).

diagnosis of osteomyelitis 3 months prior to amputation.

The average age of the patients in this group was 22 years, and varied between 16 and 38; that is, as a group, the patients were

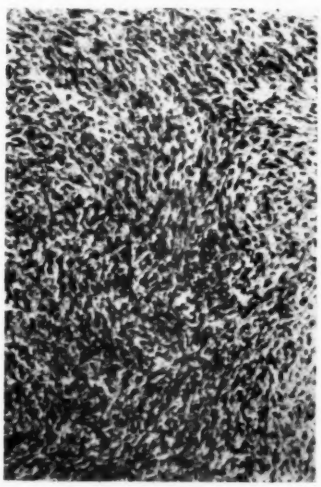

Fig. 8. Case 2. Osteogenic sarcoma. Anaplastic type (Figs. 6 and 7).

somewhat older than the patients in the anaplastic group. It must be borne in mind, however, that children under 10 are not often admitted to this hospital. Trauma was mentioned as an etiological factor in 5 of the 7 cases.

It is impossible to distinguish the fibrous type clinically or by x-ray from the other more malignant forms of osteogenic sarcoma; and as far as can be determined, the only reason why the results of treatment were satisfactory is the fact that the major part of the tumor was composed of highly differentiated cells.

Chondral type. There are 9 cases in this group, 7 of which are suitable for end-result study (Figs. 3, 4, and 5). Five are living and well, while 2 are dead of a recurrence of the disease. Pathological examination of all these tumors showed cartilage to be the predominating tissue, but portions of the tumors appeared to be highly malignant. It is often difficult histologically to distinguish between a benign chondroma and a sarcoma.

Clinically, the striking feature of this group was that 5 of the 9 patients were over 50 years of age when the tumor was first noticed.

Fig. 10. Case 66. Reticulum cell sarcoma humerus (Fig. 9).

Fig. 9. Case 66. Reticulum cell sarcoma lower end of the humerus. Male, aged 42 years. Amputation. Local recurrence removed 7 years later. Well 6 years after second operation (Fig. 10).

One of these patients probably had Paget's disease of the bones as well, but the history suggests malignant changes occurring in a previously benign tumor. This is known to have occurred in 2 instances. In Case 49, a cure, the patient had a benign chondroma removed three times. Some time after the third removal it recurred, grew rapidly, and at operation proved to be sarcoma. Comparing the specimen removed at the last operation with those removed previously, the character of the growth had changed. In another case, a chondroma had been removed 13 years previously, and the patient considered himself well during the interval. The growth then recurred and amputation was performed, but the patient died a year later of lung metastases.

The roentgenograms in these cases showed in most instances nothing characteristic that

Fig. 11. Registry of Bone Sarcoma No. 1992. This shows the characteristic appearance of one form of reticulum cell sarcoma and is to be compared with Figure 9. The case is not included in this series.

would serve to distinguish this type from other forms of sarcoma. Three of the tumors were in the upper end of the tibia, 2 in the metatarsals, and 1 each in the radius, humerus, femur, and scapula. Trauma was mentioned as an etiological factor in the history in 4 of the 9 cases. In no case in this group was the duration of the disease from the first symptom to operation less than 4 months, and in 5 instances it was over a year. In other words, the tumors were of slow growth and metastasized late in the course of the disease.

Anaplastic type. There were 21 cases in this group. Four refused treatment and 1 died of intercurrent disease (operative death following cholecystectomy) and have been excluded in determining the end-results of treatment. Of the 16 remaining, only 1 is living (5.5 per cent cures) (Figs. 6, 7 and 8). In all these cases the major portion of the tumor was composed of anaplastic cells although small areas of adult cartilage, bone, and fibrous tissue could be found. Twelve of the patients were under 22 years of age, and 4 cases were over 60, but in the latter group the disease was secondary to Paget's disease of the bone. Twelve of the 21 tumors arose about the knee joint.

Excluding the cases with Paget's disease, in 10 of the 16 patients, the symptoms were of less than 3 months' duration when the patients sought treatment, while in 2 cases, 1 a cure, symptoms had been present 4 months. The average duration of the disease from first symptom to operation was considerably less than in the two forms previously discussed, yet the tumors had obviously formed metastases when first seen.

The roentgenograms were characteristic of a malignant bone tumor and all showed bone destruction and new bone formation in varying amounts. There was no way clinically, however, to differentiate this form from that in which cartilage or adult fibrous tissue predominated.

EWING'S SARCOMA

There are 8 cases of Ewing's sarcoma in the series. All died of disease. Four were treated by amputation and 4 by x-ray, the latter cases with marked temporary improvement.

RETICULUM CELL SARCOMA

There are 2 cases of this type of tumor in the series, but I have seen others and there are several in the Registry collection. Most of the cases in the Registry have been placed under the heading "malignant disease of bone, unclassified." Recently Parker and Jackson have reviewed these cases, with others of their own, and believe the growths are identical with the so called reticulum cell sarcoma of the soft parts. Their paper appears elsewhere in this issue. These tumors run a different course from that of osteogenic sarcoma. In the early stage of the disease the symptom common to all malignant bone tumors is present, that is, pain unrelieved by rest. Later a tumor is noticed which grows rapidly, and, although it may attain considerable size, the general condition of the patient remains excellent (Figs. 9 and 10). In the roentgenogram the tumors originate in the medulla, which in the early stages has a mottled appearance (Fig. 11), and may be confused with osteomyelitis or Ewing's sarcoma. Later there is bone destruction and a bulky tumor

but no evidence of metastases. When metastases occur they are usually seen in the lymph nodes or soft parts rather than in the lungs, although the latter may be involved. When a tumor of this type is primary in the lymph nodes it runs a relatively short course, 2 to 3 years, to a fatal termination; but when primary in the bone it appears to be relatively non-malignant, although in the light of the history of these 2 cases there is apparently the possibility of a late recurrence. This might be considered another manifestation of the disease and not a true recurrence. In the 2 cases in this series the tumors were situated in the humerus, 1 in a 12 year old girl and 1 in a 42 year old man. Shoulder joint amputation was performed in both instances. The girl died 12 years later with a tumor of the femur. Unfortunately no history, x-ray, or biopsy report of this second tumor is available. The man had a massive local recurrence in the soft parts about the shoulder 7 years after amputation. This was excised and the operation followed by x-ray therapy. The patient is well today, 7 years after removal of the local recurrence and 14 years after the amputation.

These tumors are radiosensitive, but Parker and Jackson found that with the exception of the case here reported, all but 1 case in which amputation was performed were living over 5 years, while of those treated only by radiation, all were dead, or, if living, showed definite evidence of disease.

It would appear that Parker and Jackson have been able to distinguish a type of primary bone tumor, not previously recognized, which pursues a definite clinical course not in any way resembling that of an osteogenic sarcoma. It is probable that certain of the reported cases of cures of both Ewing's tumor and osteogenic sarcoma were unrecognized tumors of this character.

EVALUATION OF STUDY

From this analysis it would appear that the prognosis in a series of cases of malignant bone tumors taken consecutively as they are admitted to a general hospital, is far from hopeless when they are treated by radical surgery. Although all the cases reported were considered malignant, the time at which metastases occurred obviously varied. In reviewing the specimens, the tumors in which relatively adult tissue, such as fibrous tissue and cartilage, predominated did not form metastases for some time after the tumor was noted clinically, and the patients were therefore cured by complete removal of the growth.

The time element, that is the duration of the tumor before treatment, undoubtedly has a bearing on the result in a given case, although if these cases are considered as a group, this is not so. The prognosis appeared to be worse in the cases of short duration, but it was found that the duration in the majority of the tumors of low malignancy, in which cures were obtained, was appreciably longer. This same relation between duration of disease and prognosis has been found to obtain in studying groups of cases of cancer of the breast. There is only 1 case of short duration in this series, a 7 year cure, and this occurred in the family of a physician. There had been symptoms for about 3 weeks, although the roentgenogram suggested a tumor of longer duration, and operation was performed within 24 hours from the time the diagnosis was suspected.[1]

It is difficult to obtain the consent of the patient or the parents to amputate for a small tumor, and they will grasp at any form of treatment first that does not sacrifice the extremity.

The value of pre-operative radiation treatment is problematical. It was not employed in any case in this series, for the time element was considered more important. Radiation undoubtedly affects the cells profoundly but apparently does not destroy the tumor. There is no instance of cure by radiation alone of a proved case of osteogenic sarcoma in the Registry.

The surgical procedure adopted whenever possible was a biopsy performed with a tourniquet on the limb, frozen section examination of the tissue removed, and immediate amputation if the tumor was reported to be sarcoma. A suction biopsy done some

[1] Since this paper was submitted for publication Case 24 (Registry of Bone Sarcoma No. 1254) presented evidence of two metastases in the lung, 7 years after operation. These were successfully removed by lobectomy. The histology of the metastases was the same as that of the original tumor.

time prior to operation might disseminate the disease. Two of the cured cases of osteogenic sarcoma, however (Cases 7 and 8) had been curetted some time before amputation under the erroneous diagnosis of osteomyelitis, and one case of reticulum cell sarcoma (Case 65) had also been explored.

There is no way by which the various types of osteogenic sarcoma may be distinguished clinically with any degree of accuracy, although occasionally the character may be suspected. In individuals over 50 the tumor is usually secondary to Paget's disease of the bone (4 cases in this series) or of the chondral type (5 of 9 cases). In the chondral type it usually represents malignant changes occurring in a small pre-existing island of cartilage.

The 8 cases of Ewing's sarcoma are all dead. My experience with this tumor is limited to 26 cases, some patients being treated by radiation and some by operation but all are dead. There are a few 5 year cures, however, in the Registry collection.

The most interesting group, although small, is that of the primary reticulum cell sarcoma of bone. The nature of this disease shows a destructive process in the medulla in the epiphyseal end of the diaphysis, often multiple small areas with no new bone formation. The picture is suggestive of other forms of malignant lymphoma of bone. Later, there is a bulky tumor destroying the bone, but the patient remains in excellent physical condition. These tumors are radiosensitive, but from the data at hand the results are more satisfactory following radical surgery than following radiation treatment.

CONCLUSIONS

1. The prognosis in a series of consecutive cases of osteogenic sarcoma is not as poor as is generally believed if the tumors are removed by radical surgery.

2. Of 28 cases of osteogenic sarcoma in which amputation was done, 11 patients, 39 per cent, are living without disease 5 or more years after operation.

3. The prognosis depends more on the amount of differentiation of the cells comprising the major portion of the tumor than on any one other factor.

4. If the tumor is composed in large part of adult fibrous tissue or cartilage, the prognosis is better than if the cells show marked anaplasia.

5. In 5 cases in which fibrous tissue predominated, patients were treated by amputation. All are well (100 per cent).

6. Of 7 cases in which amputation was done and in which cartilage was the predominating tissue, 5 patients are well, 70 per cent.

7. Of 16 cases in which amputation was done and which may be placed in an anaplastic group, 1 is well (5.5 per cent).

8. Two cases of reticulum cell sarcoma in which amputation was done are reported. One patient is well 14 years later, and 1 died 12 years later of a tumor of another bone, the character of which was not determined.

9. Of 8 cases of Ewing's sarcoma, 4 patients were treated surgically and 4 by radiation. All patients died of the disease.

ABSTRACTS OF HISTORIES—CURED CASES

Case 2, Registry 407. Male, aged 31 years. Lower end femur. Pain, 1 year; trauma, 9 months; tumor, 3 months. Amputation. Pathology: sarcoma fibrous type. Low malignancy. Well 10 years.

Case 5, Registry 214. Male, aged 38 years. Lower end femur. Trauma, 16 months; tumor, 4 months. Amputation. Pathology: sarcoma fibrous type. Well 6 years.

Case 7, Registry 312. Male, aged 18 years. Lower end femur. Trauma, 4 months; curetted for osteomyelitis, 3 months. Amputation. Pathology: sarcoma fibrous type. Well 14 years.

Case 8, Registry 344. Male, aged 17 years. Upper end tibia. Trauma, 1 year; pain, 4 months; tumor, 3 months; curetted for osteomyelitis. Amputation. Pathology: highly malignant sarcoma. Well 8 years.

Case 23, Registry 945. Male, aged 16 years. Tumor upper end of tibia, 10 months; no trauma. Amputation. Pathology: osteogenic sarcoma chondral type. Well 7 years.

Case 24, Registry 1254.[1] Female, aged 21 years. Shaft humerus. No trauma; pain, 1 month. Amputation. Pathology: sarcoma fibrous with cartilage. Low malignancy. Well 6½ years.

Case 28, Registry 1572. Female, aged 16 years. Lower end of femur. Probable trauma; tumor, 4 months. Amputation. Pathology: sarcoma, central fibrous type. Low malignancy. Well 5½ years.

Case 44, Registry 945. Male, aged 18 years. Upper end of tibia. Trauma, 9 months; tumor, 3 months. Amputation. Pathology: osteogenic sarcoma chondral type. Well 6 years.

[1] See footnote under "Evaluation of Study."

Case 47, Registry 1217. Female, aged 68 years. Scapula. Trauma, 11 months; pain, 6 months; tumor, 3 months; excision of scapula. Pathology: osteogenic sarcoma chondral type. Local recurrence in 11 months. Excised. Well 5 years after second operation.

Case 48, not registered. Female, aged 59 years. Lower end of radius. Trauma, 5 years, followed by pain and swelling. Three minor operations performed with no improvement. Amputation. Pathology: osteogenic sarcoma chondral type. Well 5 years. A probable example of a chondroma assuming malignant qualities.

Case 49, Registry 2133. Male, aged 15 years. Upper end of tibia. Tumor, 5 years; no trauma; removed 3 times by wide local excision but recurred. Pathology: chondral type. Well 5 years. A typical example of a benign chondroma changing its character and becoming malignant.

Case 65, Registry 63. Female, aged 12 years. Upper end of humerus. Tumor, 3 months; curetted for osteomyelitis. Amputation. Pathology: probable reticulum cell sarcoma. Said to have died 12 years later of a tumor of the lower end of the femur. Unfortunately we do not know the character of the tumor of the femur. It was probably another manifestation of the disease and should not be considered as a true recurrence.

Case 66, Registry 564. Male, aged 44 years. Lower end of humerus. Pain, 10 months; fracture, 5 months; tumor, 2 months. Amputation. Pathology: reticulum cell sarcoma. Recurrence in soft parts about shoulder 7 years later. Excised. Radiation. Pathology, same. Well 6 years after second operation.

I do not consider this man necessarily cured, for I think these tumors belong in the lymphoma group and later manifestations of the disease may develop.

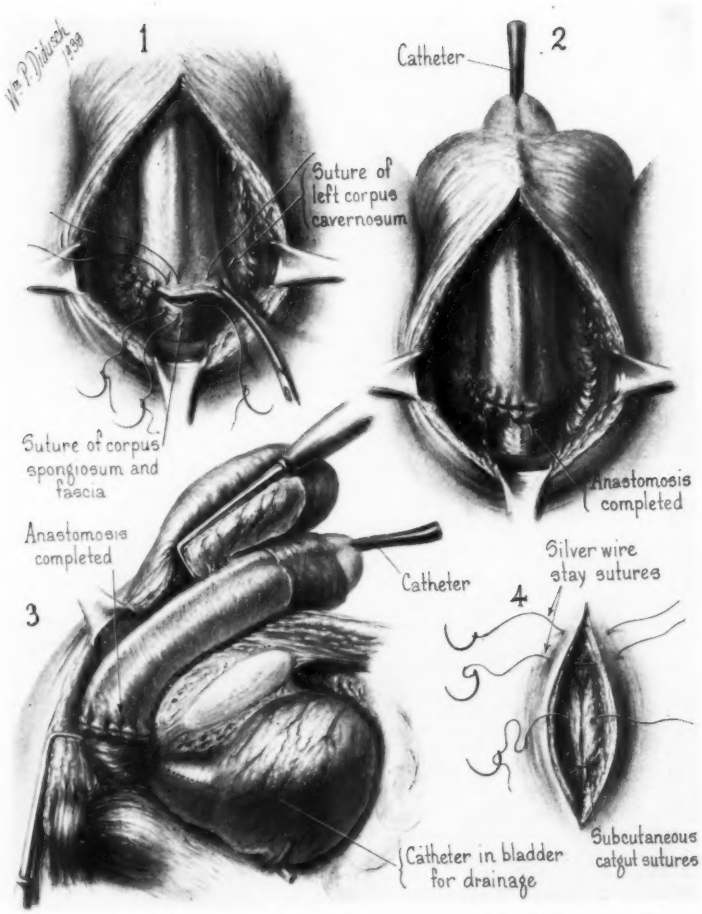

Fig. 7. Completion of approximation by suturing fasciæ covering corpora cavernosa and spongiosum with bulb and crura. *3*, Lateral view showing extent to which penis was drawn backward and telescoped to fill defect and provide continuity of urethra. Catheter in place for drainage. *4*, Closure of wound. BUI 26189.

A New Radical Operation for Carcinoma of the Bulbous Urethra.—Hugh H. Young.

CLINICAL SURGERY

FROM THE JAMES BUCHANAN BRADY UROLOGICAL INSTITUTE

A NEW RADICAL OPERATION FOR CARCINOMA OF THE BULBOUS URETHRA

A New Use for the Penis

HUGH H. YOUNG, M.D., F.A.C.S., Baltimore, Maryland

THE case of carcinoma of the bulbous urethra which is described here seems worthy of report, inasmuch as it furnishes a completely radical procedure without mutilation or stricture. In this patient, after an extensive block dissection, a great urethral hiatus was eliminated by telescoping the penis backward and suturing it to the triangular ligament.

CASE REPORT

BUI 26189, J. B. D., a man, aged 59 years, was admitted September 21, 1937, complaining of a gradually increasing lump about the urethra in the region of the scrotum and perineum of 2 months' duration. The family history was negative, and the past history was non-contributory. He had had acute gonorrhea 40 years ago. This disappeared under local treatment, but subsequently he had prostatitis, for which he was treated 20 years ago. His physician reported that he had not had a prostatitis recently and that his Wassermann test was negative. His sexual powers were normal, and several months before admission he was having intercourse about every 10 days. Three years ago, at the age of 56, the patient noticed some hesitancy at the beginning of urination, and a decrease in size of stream. A diagnosis of urethral stricture was made, and he was treated by the passage of sounds, beginning with No. 18 F. These dilatations were continued at intervals of about 5 weeks for 3 years, a No. 29 F sound being frequently introduced. These treatments kept the urethra dilated so that urination was quite satisfactory until about 2 months ago, when, following the passage of a No. 29 F sound, he noticed marked discomfort in the urethra. On palpation the patient then felt a pea-sized lump along the urethra in the perineum. After that the lump gradually increased in size until it reached about an inch or so in length. He was treated by diathermy with no reduction in the size of the indurated area. After the onset of the induration there was a complete cessation of erections and libido. Recently it had been found impossible to pass a sound of the usual size, and difficulty in voiding urine had returned.

The patient was referred by Dr. William R. Barron, Columbia, South Carolina, who had found a markedly indurated area around the urethra which he considered suspicious. The patient was voiding urine without much difficulty or frequency and was enjoying excellent health, but had had no libido, erections or coitus for several months. He complained of a hard mass around the urethra, back of the scrotum, which gave him no pain. There was no history of hematuria or urethral discharge.

On examination the penis and scrotum appeared normal (Fig. 8). Palpation along the urethra revealed a markedly indurated area around the urethra beginning at the penoscrotal junction and extending back for a distance of about 5 centimeters. The mass was hard, slightly irregular, somewhat fixed, about 2.5 centimeters wide, and apparently entirely within Colles' and Buck's fasciæ. The skin and subcutaneous tissues and the scrotum and its contents were not fixed to it. The posterior part of the bulb and crura of the penis were negative. The mass, about 5 centimeters in length, was not adherent to, and apparently did not involve, the symphysis pubis or the ischiopubic rami. Its location is shown in the clinical sketch (Fig. 1 and also in Fig. 2, *1*). No enlarged glands were found along the penis, in the perineum, or in the groin on either side. The testicles, epididymides, vasa, and veins were negative. On rectal examination the anal sphincter and rectum were found to be negative. The prostate was about normal in size, shape, and consistence. The seminal vesicles were slightly indurated. The membranous urethra was soft and normal in size. With the finger in the rectum and the thumb on the perineum one found slight enlargement and a little thickening of the bulb at or near its posterior limit. A short distance below this point an indurated mass was felt which surrounded the urethra and rapidly became wider and thicker, apparently involving much of the bulb and urethra. The mass was movable, not adherent to the lateral structures of the perineum, and stopped abruptly near the penoscrotal junction. Bougies à boule and catheters introduced in the urethra met with an impassable obstruction within the scrotal portion of the urethra where the hard mass was palpable. It was so dense that no effort was made to pass filiforms, followers, or sounds, as the diagnosis of carcinoma seemed evident.

The urine was clear; acid; specific gravity, 1020; no albumin, sugar or white blood cells were present, and only 1 or 2 red blood cells per high powered field. No infection was seen. The phthalein test showed an appearance time of 8 minutes, and half hourly outputs of 56, 20, 12, and 4 per cent; two hour total 92 per cent. The blood urea was 28 milligrams per cent; hemoglobin 100; leucocytes, 7,350.

The diagnosis was coronary arteriosclerosis, heart disease, a subsiding upper respiratory infection, and malignant tumor of the urethra. As a portion of the bulb and urethra back of the tumor were apparently free from invasion, the possibility of a radical operation seemed excellent.

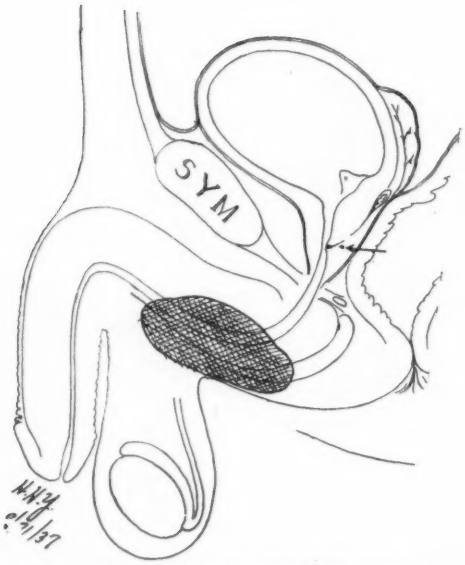

Fig. 1. Clinical chart showing location and size of carcinomatous mass. BUI 26189. Arrow indicates negative prostate; cross hatched area, very hard mass around anterior half of bulbous urethra.

Operation was carried out September 22 (by H.H.Y.), using avertin-gas-ether anesthesia. A McCarthy urethroscope was introduced before the operation was started and revealed a slight irregularity and marked narrowing of the urethra in the region of the mass, but no ulceration or projecting neoplastic tissue was visible. With the patient in the position for perineal prostatectomy an incision 6 centimeters long was made in the midline of the perineum just behind the scrotum, which was pulled forward (Fig. 2, *2*). Colles' fascia covering the bulb of the urethra was isolated on each side to the ischiopubic ramus. It was smooth, but beneath it a markedly indurated mass occupying the anterior two-thirds of the bulb, and extending up to the scrotal portion of the penis was found (Fig. 2, *3*). After exposing Colles' fascia, which covered the cavernous bodies, palpation of the mass showed that it was of third degree induration and slightly irregular. There were no areas of softening and nothing suggesting local areas of suppuration or sinuses. It seemed evident that the diagnosis was surely carcinoma, but before I began the proposed very radical operation it seemed wise to take a biopsy. An incision was made on the posterior surface of the mass. Colles' fascia and the tissue immediately beneath it did not appear to be involved, but the scalpel soon encountered the markedly indurated tissues which on cut section gave every evidence of being carcinoma. Nevertheless, a wedge-shaped piece (Fig. 3, *1*) was removed and the wound packed while the operator waited for the report on microscopic examination of the stained frozen section. In 10 minutes the diagnosis "carcinoma" was received, and we proceeded to carry out a very extensive radical operation (Fig. 3, *2*) to remove the mass with its surrounding fasciæ and a goodly portion of the cavernous bodies anteriorly, and much of the uninvolved bulb behind. The scrotum was retracted well forward and blunt dissection was continued downward outside the fasciæ covering the corpora (Colles' and Buck's) until a point about 2 centimeters below the lower margin of the indurated mass was reached. A clamp was then passed around the cavernous bodies and their fasciæ, and a transverse incision was made through the corpus spongiosum and corpora cavernosa (Fig. 3, *1*); thus the scrotal portion of the penis was completely severed. On examination it seemed desirable to remove more of the cavernous bodies and a second incision was made transversely through them at a point about 1.2 centimeters farther down (Fig. 3, *1*). (In the drawings, Fig. 3, *1* and *2*, only this incision is shown.) After the cavernous bodies were divided, the fascia covering them was seized with forceps, and by sharp and blunt dissection they were freed from the structures in front. A suspensory ligament was recognized and divided, and the adhesions to the anterior surface of the pubes and ischiopubic rami on each side were divided close to the bony structures (Fig. 4, *1* and *2*). The dorsal arteries and veins were divided, bled freely and required ligation, both at the upper and lower end of the dissection. When the mass was pulled outward and the dissection carried backward, the crura of the corpora cavernosa were encountered on each side, and divided close to the ischiopubic rami (Fig. 5, *1*). One could then palpate the urethra as it left the bulb and penetrated the triangular ligament. Below it was a portion of the bulb which was free from involvement for several centimeters behind the malignant mass. A clamp was placed beneath the urethra, and an incision was then made through the bulb just in front of its posterior limit (Fig. 5, *2*). This incision was continued through the urethra at a point about 1 centimeter in front of the triangular ligament (Fig. 5, *3*). The mass with its surrounding fasciæ and uninvolved tissue of the bulb behind and the cavernous bodies below was removed. After all hemorrhage had been carefully arrested, inspection showed a dis-

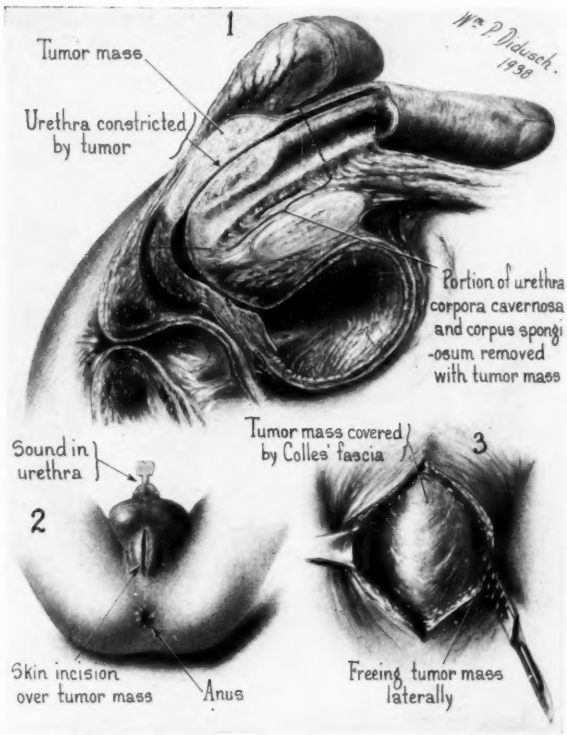

Fig. 2. *1*, Schematic sectional view showing location of carcinomatous mass involving corpora cavernosa and spongiosum. Dotted lines indicate extent of resection. *2*, Perineal incision extending up on scrotal portion; subcutaneous blunt dissection exposing Colles' fascia. BUI 26189.

tance of about 9 centimeters between the stump of the urethra behind and the section of the urethra and cavernous bodies anteriorly (Fig. 5, *3*). The anterior portion had retracted into the depths of the scrotal wound. By grasping the fasciæ with forceps, we found it possible to draw the remaining cavernous bodies of the penis backward without difficulty until they could be made to touch the cut end of the urethra posteriorly (Fig. 6, *1*). In so doing the penis was telescoped within the penoscrotal pouch until only the glans penis was visible (Fig. 6, *1* and *2*). Anastomosis of the two cut ends of the urethra was then made with fine 10 day catgut, a continuous stitch being employed (Fig. 6). A catheter was introduced just before closure of the line of urethral sutures. The cavernous tissues and surrounding fasciæ were then drawn together with interrupted sutures of plain catgut (Fig. 7, *1*) some of which were placed in the stumps of the crura on each side, some into the deep structures of the triangular ligament. The anastomosis was easily carried out without tension and seemed entirely successful. It was surprising how easily the penis had been drawn back to be sutured to the triangular ligament (Fig. 7, *2* and *3*). The subcutaneous tissues were then drawn together in the median line with interrupted plain catgut sutures, and the skin was closed with silver wire sutures. Examination showed the glans and about 1 centimeter of the shaft of the penis protruding from a pouch at the penoscrotal juncture (Figs. 7, *3* and *8*). The contrast between the length of the penis before and after operation is shown in Figure 8. The scrotal contents appeared normal. The catheter, which had been introduced, was fastened in the penis with adhesive, the

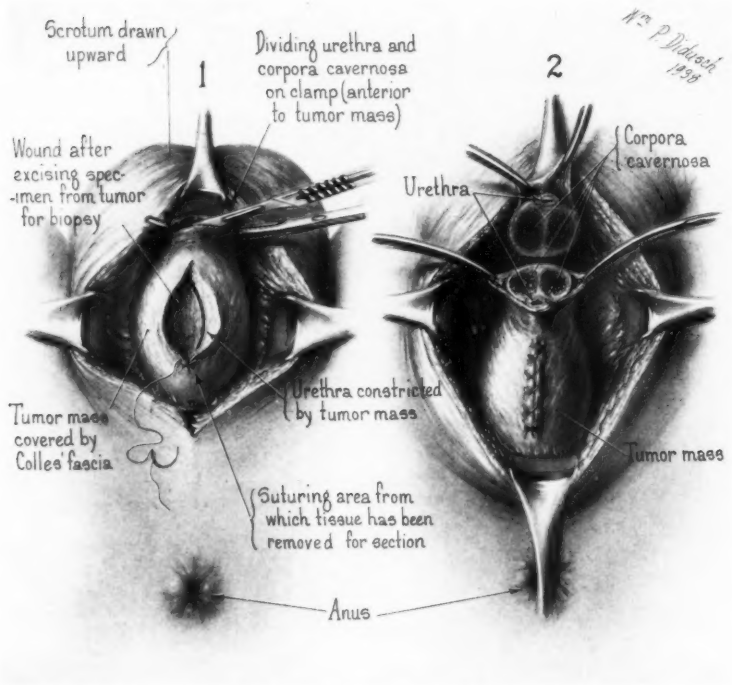
Scrotum drawn upward
1
Dividing urethra and corpora cavernosa on clamp (anterior to tumor mass)
2
Wound after excising specimen from tumor for biopsy
Corpora cavernosa
Urethra
Urethra constricted by tumor mass
Tumor mass covered by Colles' fascia
Tumor mass
Suturing area from which tissue has been removed for section
Anus

Fig. 3. *1*, Section through Colles' fascia into indurated mass for biopsy. Incision was closed while waiting for microscopic report (see *2*). After isolation of root of penis and careful avoidance of penetration of Colles' and Buck's fascia, a clamp was placed around 3 corpora well up in scrotal portion of urethra which was made visible by firm retraction of scrotum. *2*, Division of corpora and beginning isolation of posterior part of penis and perineum. BUI 26189.

bladder was washed clean, and a drainage apparatus was attached. The operation had not been difficult and was apparently thoroughly radical and satisfactory.

Two specimens were removed at operation, the larger weighing 27 grams and measuring 3.3 by 3.3 by 2.5 centimeters; the smaller, which was a transverse section of the three corpora of the penis, measured about 1.3 centimeters in thickness. The urethra in the larger specimen measured 3.3 centimeters in length and was surrounded by the tumor. The urethra appeared normal. No nodules or ulceration of the mucosa were visible. Immediately beneath the mucous membrane was found a firm, hard, nodular mass between the urethra and the corpora measuring 2.5 by 1.3 by 1.3 centimeters. Three sections were taken through the urethra, tumor, and corpora for sections.

On microscopic examination of the tissue, a squamous cell carcinoma of the urethra was seen. The framework was made up of fairly dense fibrous tissue, and scattered throughout this were seen small irregular nests of tumor cells which were characterized by great variation in size, shape, and staining characteristics. In the center of many of these nests were found epithelial cells with varying stages of keratinization. The urethral mucosa was lined with normal transitional cells. Adjacent to it, but not involving it, was a tumor mass above described. In places the tumor cells were characterized by huge clear cytoplasm and small round pycnic nuclei. One group of these cells was closely packed together without intervening stroma. On the opposite side of the urethra a section of one corpus cavernosum appeared entirely normal.

The catheter was removed from the urethra on the sixth day after operation. Following this the patient voided some urine through the incision but it healed completely in 18 days. There was a marked urethral discharge which soon disappeared. The patient left the hospital one month after operation, voiding freely without pain and with excellent control. He had no urethral instrumentation after removal of the inlying catheter. He was given mandelic acid by mouth, because of a urinary tract infection with the Staphylococcus aureus. He was advised to continue this on returning home.

On April 21, 1938 the patient returned for observation (7 months after operation). He had had no instrumentation. He voided urine freely in good stream at intervals of 6 hours, night and day, and often did not arise at night.

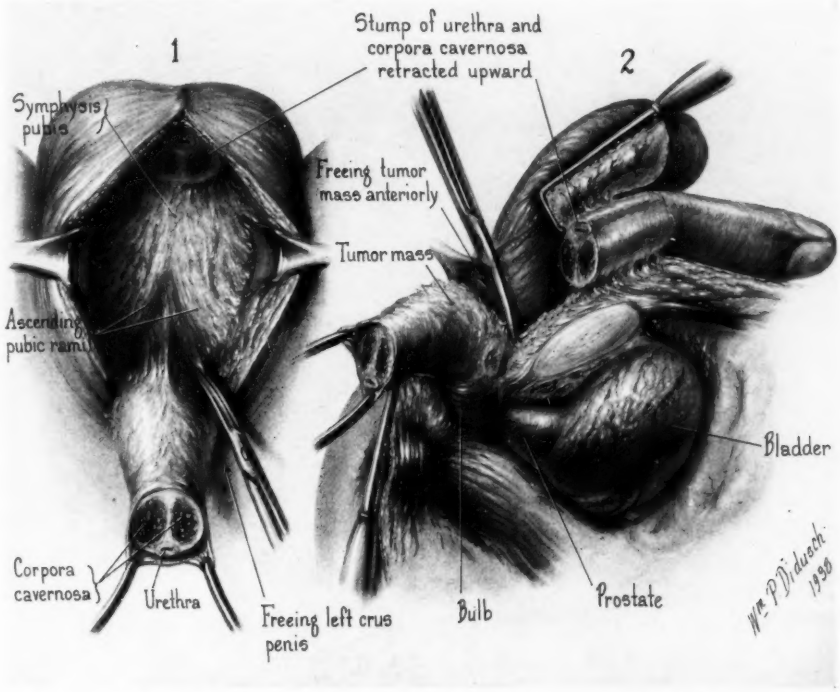

Fig. 4. *1*, Colles' fascia has been cut away from ischiopubic ramus on each side. Suspensory ligament has been divided and mass dissected backward, exposing anterior surface of symphysis and ischiopubic rami. Penis has retracted into scrotum. *2*, Continuing deep dissection. BUI 26189.

He had no pain, local or remote. He had not lost weight, and was enjoying excellent health. He had had no erections (but these were stated to have been absent 2 months before operation).

The patient looked well and weighed 175 pounds. The penis was normal in width but very short (Fig. 9). The glans measured 4 centimeters wide and 3.5 centimeters long. Above this the shaft of the penis could be followed into a pouch beneath the pubic fat for a distance of 3.5 centimeters. In the median line of the perineum was a narrow scar 7 centimeters in length and with very little induration. On palpation much less tissue than usual was found in the region of the bulb. Far forward, in the region of the scrotum, the cavernous bodies felt about normal in size. Passing backward they became gradually smaller down to the point where the anastomosis was made just below the external sphincter. No bulb and no crura were palpable. There was very little cicatrix at the site of anastomosis and elsewhere the tissues were soft. There was nothing to suggest a recurrence. No enlarged glands were palpable in either the perineum or the groins. On rectal examination the prostate was found to be negative and no glands were palpable. The patient voided about 500 cubic centimeters of clear urine. No sounds or other instruments were passed.

One year after operation the patient was reported to be well.

REPORTED CASES

Primary carcinoma of the male urethra is comparatively rare. In 1923, after reporting 1 case, Kretschmer brought the total number in the literature to 80. In 1931, Lower assembled 112 cases to which he added 3 cases that had come under his personal observation. In 1932, Kirwin after excluding certain reports stated that the total number of acceptable cases of carcinoma of the male urethra in the literature was 99. In 1937,

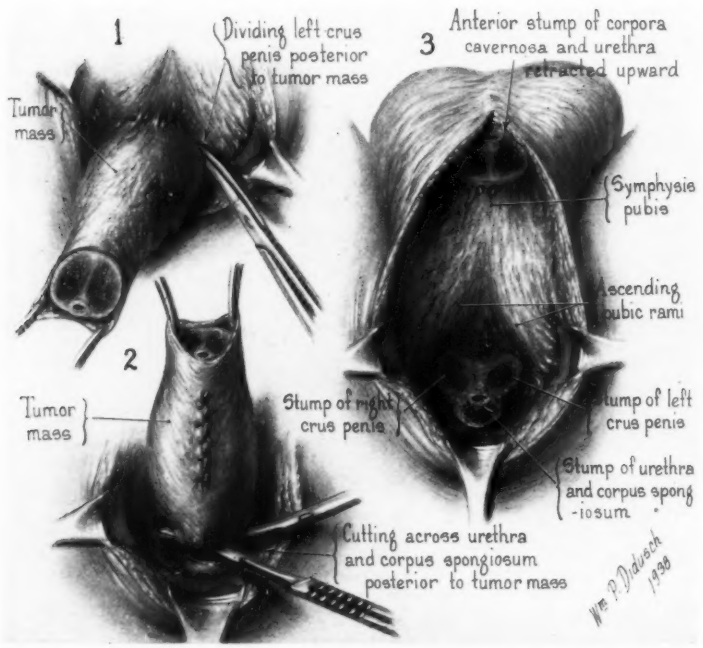
1
Dividing left crus penis posterior to tumor mass
Tumor mass
2
Tumor mass
Stump of right crus penis
Cutting across urethra and corpus spongiosum posterior to tumor mass
3
Anterior stump of corpora cavernosa and urethra retracted upward
Symphysis pubis
Descending pubic ramu
Stump of left crus penis
Stump of urethra and corpus spongiosum
Wm P. Didusch 1938

Fig. 5. *1*, Left crus being divided. *2*, Clamp has been placed in front of urethra just below bulbomembranous junction and bulb is being divided. *3*, Large cavity left after removal of urethra and 3 corpora with surrounding fasciæ intact. Two ends of urethra are about 3.5 inches apart (9 cm.). Problem was what to do to close extensive defect. BUI 26189.

Harbach added 7 cases which had been collected by McNally and 1 by himself, bringing the total number in the literature to 107. In 1938, Kreutzmann and Colloff stated that after a very thorough search of the literature they found 143 reported cases, many of which had not been mentioned by any authors since the original publication. To this list they added 2 new cases, making the total of 145 reported to date. When one considers the number of papers that have been written on the subject, the fact that only 145 cases have been reported is sufficient to show the comparative rarity of the disease. At this clinic we have had 84 cases of carcinoma of the penis, but only 5 cases of carcinoma of the urethra.

In the early literature Thaudiere was given credit for the first report of carcinoma of the urethra. There was an obstruction in the spongy urethra at a depth of about 1.5 inches. The author incised the superior surface of the glans, dissected out the tumor, which was the size of a pea, from the wall to which it was adherent. Kirwin, after studying the original report, decided that, as the patient was a young man and was cured by a small excision of tissue and cauterization, the case could not be accepted as one of carcinoma. The first apparently acceptable case was that of Hutchinson, which was presented to the London Pathological Society in 1861, but the first paper of real importance was that of Wassermann, who presented, in 1895, 20 cases in the male, 24 in the female, and 3 cases in which the lesion was located in Cowper's glands. Since then the literature contains papers by Soubeyran (1902), Tanton (1910), Scholl and Braasch (1922), and the papers by Kretschmer and the others mentioned above, to which publications the reader is referred for complete bibliographies.

ETIOLOGY

Inflammatory irritation causing metaplastic changes in epithelial surfaces has been cited as the principal etiological factor by numerous writers. Bohm thought that this was the cause of carci-

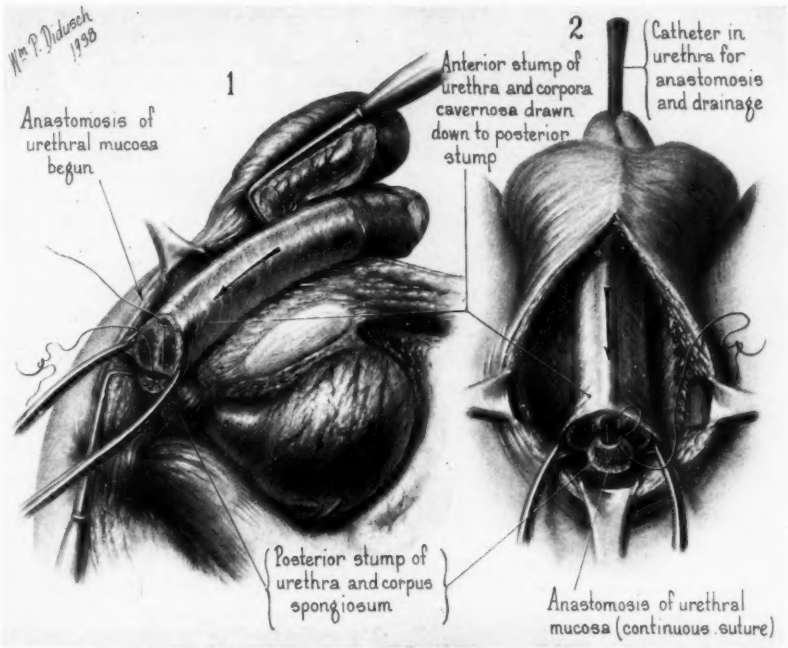
Wm. P. Didusch 1938
1
Anastomosis of urethral mucosa begun
2
Catheter in urethra for anastomosis and drainage
Anterior stump of urethra and corpora cavernosa drawn down to posterior stump
Posterior stump of urethra and corpus spongiosum
Anastomosis of urethral mucosa (continuous suture)

Fig. 6. It was found to be easy to draw penis backward so as completely to cover defect and anastomose two ends of urethra and corpora. BUI 26189.

noma in the intestinal tract; Deetz in the biliary tract; Hallé in the renal pelvis and ureter; Wassermann and Cederkreutz in urethral carcinoma. Scholl and Braasch adopted this view and say that Kittel and Kaufmann demonstrated definite epithelioma associated with urethral stricture, but that Thiersch was the first to call attention to malignant transition of these cicatrized areas and to report a case of squamous cell epithelioma developing in a case of long-standing stricture. In 1904 Poesner collected 20 cases in the male urethra, in 12 of which urethral stricture had been present. Other authors have reported cases in which carcinoma followed traumatism, generally to the perineal urethra. Kretschmer admitted that stricture often led to metaplasia or leucoplacia of the urethral mucosa, but he asserted that carcinoma may produce symptoms of stricture early in its course and lead to an erroneous diagnosis. In a paper by Kretschmer we read that since "gonococcal infection of the male urethra is common and carcinoma rare, the gonococcus plays little if any etiologic rôle in the production of this disease."

PATHOLOGY

Primary carcinoma of the male urethra has been classified as follows: (1) squamous cell, (2) columnar cell, (3) papillary, and (4) adenocarcinoma. All authors are agreed that the squamous cell carcinoma is by far the most frequent (in Preiswerk's series of 42 cases, all but one). In Kretschmer's series of 80 cases he found none of the columnar type and considered that the papillary carcinoma, of which he presented a case, was also very rare. When adenocarcinoma was found, the origin was thought to have been Cowper's glands in most cases, but it was admitted that a true adenocarcinoma might begin in other peri-urethral glands, although this apparently was extremely rare. In a study made by Young and Davis (1926) it was stated that "metastases in epithelioma of the urethra are usually late. Regional metastasis is to the iliac or inguinal nodes, or both. If the growth is posterior to the suspensory ligament, there is little chance of metastasis to the inguinal nodes. From the urethra lymphatic drainage goes to the external iliac, hypogastric, and sacral groups of nodes so that any of these may be involved. In 2 cases

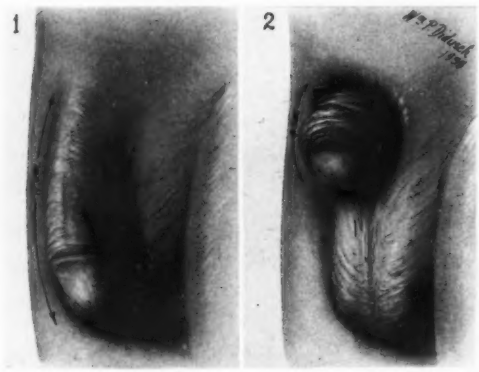

Fig. 8. Comparative views of penis before and after operation. Only glans and small portion of shaft were visible after operation. BUI 26189.

cited by Imbert, metastasis to the testis and in another to the bladder were present. In several reports in the literature, in which cases of epithelioma of the pendulous urethra are cited, metastasis to the inguinal glands were found, and most authors are agreed that if amputation of the penis is done, removal of the inguinal nodes, preferably a block dissection along with the penis, should be carried out. Lazarus stresses the importance of employing the technique of block dissection devised by Young for carcinoma of the penis, and reports a case in which he employed this method.

OPERATIVE TREATMENT

Kretschmer expressed the generally accepted surgical opinion in 1923 as follows: "Just as soon as the diagnosis has been made, nothing short of a radical operation should be employed, viz., amputation of the penis with transplantation of the urethra and complete extirpation of the inguinal glands." This opinion has been concurred in by various writers since that date. Some of the early authors advised complete emasculation, but recent writers have agreed that such mutilation is not helpful or necessary. Huggins and Curtis (1929) stated that for lesions of the anterior third of the urethra simple amputation should suffice, but that for urethral carcinoma between this point and the membranous urethra, more extensive removal with perineal implantation of the urethra was indicated and that "for cavernous lesions the entire penis with crura and urethra down to the membranous urethra should be excised." They reported a case in which this very extensive and mutilating procedure was carried out. In the older literature cases are reported in which excision of the carcinomatous area through the perineum with cauterization of the wound was carried out.

A detailed study of cases of squamous carcinoma of the bulbous portion of the urethra was made by Marcus Beck in 1892. All the cases were inadequately treated, except possibly that of Mikulicz, which was as follows:

In 1883 Mikulicz operated upon a patient with carcinoma of the bulbous urethra. There was a fistula present which was laid open, thus exposing a cavity the size of a hen's egg. When the superficial granulations were scraped away, a tissue was exposed resembling squamous carcinoma of the lip. The whole penis with the crura was removed, but recurrence took place in 4 months. Microscopic examination proved the growth to be a squamous carcinoma.

Oberlaender (1893) reported the case of a man, aged 76 years, who had been treated for 4 years for a stricture of the urethra. It was discovered by endoscopic examination to be carcinoma. The tumor was in the region of the bulb, the size of a chestnut and somewhat lobulated. It was excised with the urethra 1.5 to 2 centimeters above and beneath the tumor. The ends were closed together with "catgut sutures." Healing followed by primary intention in 3 weeks. The extirpated inguinal glands were negative. In 7 months the patient returned with a local recurrence which was easily palpable and visible endoscopically. Examination of the specimen showed around the lumen of the urethra a half circular tumor 4.5 centimeters long and 2.3 centimeters thick; microscopy showed flat epithelial cells. (Comment by H.H.Y.: It is evident from the description that the corpora cavernosa were not removed.)

In 1922 Scholl and Braasch reported a case of a man "with a hard nodular mass 2 centimeters in diameter in the perineum at the penoscrotal angle" associated with a tight stricture of the urethra. "At operation a growth 4 centimeters long was found at the junction of the membranous (bulbous?) and anterior portions of the urethra. The involved area was completely excised. Later complete emasculation of the penis and testicles with dissection of the inguinal glands was advised but refused by the patient. . . . The specimen showed an irregular, firm tumor about 3 centimeters in diameter—a squamous cell epithelioma. Six weeks later the urethra was reconstructed from a section of the internal saphenous vein. Two months later the area had completely healed save for a persistent perineal sinus. Radium (350 mgh.) was applied to the urethra in the region of the scar through the perineal sinus. The patient was alive at the end of 5 years."

Kretschmer (1923) reported a case of carcinoma of the urethra in which he had carried out amputation of the penis, transplantation of the urethra to the perineum, and removal of the inguinal glands *en masse*. Similar operations by various authors are to be found in the literature.

Emasculation has been frequently performed by European surgeons, but no evidence of involvement of the testis is found in any of the reported cases. Lower (1931) reported 3 cases.

His first was a "man aged 58 who suffered injury to the perineum some years previously. . . . Two years before admission he had an acute retention caused, he said, by a cyst of the urethra. . . . The perineal incision had been made. This was followed by fistula. . . . Acute retention was present. A suprapubic puncture was made. . . . Later an operation was undertaken for the relief of stricture. . . . I was not sure that the condition was malignant, although it was unusually hard. The operation consisted of opening the bladder and passing a sound retrograde. At the tip of the sound in the perineum the urethra was divided. The mass was dissected free and the distal end of the urethra severed beyond the involved tissues. About 1.5 inches of urethra was resected. By passing a number 18 catheter from the meatus, an end-to-end anastomosis was made. Convalescence was rather slow, but after a reasonable time the catheter was removed. The small perineal fistula . . . remained but soon closed. Regular dilatation has been continued. . . . The patient is in good physical condition and there is no evidence of recurrence after 9 years." The histologic diagnosis was squamous cell carcinoma.

Lower's Case 2. "A man aged 40 had gonorrhea at 22. Eleven years before he had acute retention which was relieved by perineal incision . . . followed by a stricture requiring frequent dilatations. Acute retention was present and I was unable to pass any instrument through the stricture. . . . A suprapubic puncture was done. A very indurated area was found in the perineum. A diagnosis of malignancy was made. A resection was done as in the previous case and x-ray therapy given. . . . A union at the point of anastomosis at the ends of the urethra was not very satisfactory and a tight stricture resulted. Internal urethrotomy was performed 2 years later and since then dilatation at regular intervals has been done. There is no evidence of recurrence after 8 years." Histologic diagnosis: papillary carcinoma.

Lower's Case 3. A man, aged 61 years, had gonorrhea at the age of 25. He was admitted with difficulty of urination. "An extensive induration was present in the perineum extending along the entire urethra. The inguinal glands on both sides were involved. Biopsy of the gland showed malignancy. Nothing short of an extensive block dissection seemed worth while. . . . The penis, testes, and inguinal glands on both sides were removed and the urethra transplanted into the perineum. Bilateral hernias were present which were successfully corrected after the testes and inguinal glands were removed. . . . It is now 3½ years later and there is no evidence of recurrence."

As shown by the literature, the operative results have been far from satisfactory. Of the 72 cases collected by Watson 79 per cent of the patients were dead within 6 months. Diehl puts the mortality rate at 80 per cent. Kreutzmann and Colloff in January, 1938, stated that they found

Fig. 9. Photograph taken 7 months after operation showing great shortening of penis. BUI 26189.

143 cases of carcinoma of the male urethra in the literature. For clinical purposes they listed the growths into "two main groups, depending on their location: (1) those occurring in the anterior or penile portion of the urethra, and (2) those found in the bulbomembranous or posterior portion. Anatomically, the bulbous portion is not a part of the posterior urethra, but for a study of their results, this arbitrary division is a rational one. In 60 of the 143 cases the carcinoma occurred in the anterior portion of the urethra. Seventy-eight patients had carcinoma of the posterior portion of the urethra. The growth was found most often in the bulbous or membranous part and occasionally in the prostatic part". . . . The different forms of treatment described are "suprapubic cystostomy, internal or external urethrotomy or both, incision and drainage of the perineum, resection of the urethra and the growth, fulguration and application of radium, excision of the inguinal or the deep femoral glands, total emasculation, passage of sounds and the use of an indwelling catheter. In this series of 78 patients with cancer of posterior regions only 11 (14.3 per cent) recovered, while 58 (74 per cent) died. In 9 (11 per cent) there was no mention of the end-result. The operation which gave the greatest number of cures was resection of the urethra with the included growth. This was performed in 5 [cases of Lower, Sokolov, Scholl and Braasch, and Oberlander]. In 1 of the 5 the inguinal glands were removed. In a second the penis was amputated and in a third radium was applied after operation. In contrast to the gratifying end-results obtained in the treatment of the growths involving the anterior portion of the urethra, carcinoma of the posterior portion possesses a gloomy picture."

RÉSUMÉ

A thorough study of carcinoma of the male urethra is to be found in recent literature. Our

paper is intended primarily to discuss the operative treatment of carcinoma of the bulbous urethra, but we have referred briefly to carcinoma of the penile and also of the membranous urethra. The accepted operative procedures, as outlined by various authors, for carcinoma of different parts of the urethra have been given.

Cases of carcinoma of the bulbous urethra that have been subjected to radical operation have been quoted in detail.

From these studies it seems evident that the technique employed in the case which forms the basis of this report is the only one in which a large growth involving the three cavernous bodies in the bulbous urethra has been radically excised with all three cavernous bodies but without removal of the penis. This was accomplished by division of the urethra and three corpora anteriorly at the penoscrotal juncture and posteriorly close to the membranous urethra. The great defect produced by this extensive removal of the urethra and three corpora has, for the first time, been closed by pulling back (telescoping) the penis and anastomosing it to the stump of the bulbous urethra near the triangular ligament.

It seems that this technical procedure has not previously been carried out. The ease with which it can be accomplished and the elimination of the great urethral defect by means of backward displacement of the shaft of the penis and anastomosis of the penile urethra to the bulbomembrane without tension are remarkable factors.

This operation might also be applied satisfactorily to urethral carcinoma of the scrotal and upper penile portions, and thus perineal transplantation of the stump of the urethra and loss of the penis avoided. Total emasculation is thus avoided by this new operation.

CONCLUSIONS

Study of the 145 cases of carcinoma of the male urethra shows that the larger proportion are situated back of the penoscrotal juncture.

Early radical operation is recognized as of prime importance when the lower penile urethra is alone involved. Amputation in continuity with block dissection of inguinal glands is the accepted procedure.

For carcinoma farther up the urethra (high penile and bulbous), complete removal of the penis and bulbous urethra, in part, with transplantation of the posterior portion into the perineum has been the accepted procedure.

For these cases a new method is proposed by means of which the penis is spared and the great defect, left after removal of the bulbous and scrotal portions of the urethra along with the three cavernous bodies, is done away with by drawing the penis back into the perineum and suturing it to the bulbomembranous urethra and triangular ligament. This operation allows more radical excision of the perineal structures involved and avoids amputation of the penis, or plastics which lead to stricture. It is both radical and conservative.

I wish to thank Dr. Wyland F. Leadbetter, resident urologist, for much assistance, and Mr. William P. Didusch for the beautiful drawings which have so completely illustrated our operative technique.

BIBLIOGRAPHY

1. Beck. Internat. Clin., 2d series, 1892, 2: 256.
2. Harbach. J. Urol., 1937, 38: 411.
3. Huggins and Curtis. Surg., Gynec. & Obst., 1929, 48: 544.
4. Kirwin. J. Urol., 1932, 27: 539.
5. Kretschmer. Arch. Surg., 1923, 6: 830.
6. Kreutzmann and Colloff. J. Am. M. Ass., 1938, 110: 184.
7. Lower. Tr. Am. Ass. Genito-Urin. Surg., 1931, 24: 249.
8. Mikulicz. Quoted by Beck. Internat. Clin., 2nd series, 1892, 2: 256.
9. Oberlaender. Internat. Centralbl. f. d. Physiol. u. Path. d. Harn. u. Sex. org., 1893, 4: 244.
10. Scholl and Braasch. Ann. Surg., 1922, 76: 246.
11. Sokolov. Quoted by Goldstein. Ann. Surg., 1937, 105: 213.
12. Watson. J. Urol., 1929, 21: 217.
13. Young's Practice of Urology. Philadelphia and London: W. B. Saunders Co., 1926.

FRACTURES OF THE NECK OF THE FEMUR

Open Operation and Pathologic Observations. A New Incision and a New Director For The Use of a Simplified Flange

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EVEN before the days of Delbet, it is probable that men were attempting to apply some form of internal fixation for fractures of the neck of the femur to facilitate union and to shorten the disability.

However, our present concept of the operative treatment of this most difficult fracture has, with few alterations, been handed down from Delbet. He used bone grafts, nails, screws, and whole grafts of the fibula. Since then, many men, time and again, have advocated the use of these methods, only to have them fail to produce good results, apparently because of the failure of the proximal fragment to live and produce new bone.

In relation to the origin of directors for forcing bone or some other foreign material into the femur, we are also indebted to Pierre Delbet for having devised the first mechanical apparatus to aid the insertion of any material for internal fixation. It was first described in 1911 and was called the *canon de Delbet.*

Charbonnier also made a rather simple appliance, using the spine of the ilium and the symphysis pubis as the fixed points and then, by the use of a movable perpendicular third part, marking the center of the head so that a drill hole could be guided by this marker. Charbonnier described this apparatus first in 1923 and then again in 1932.

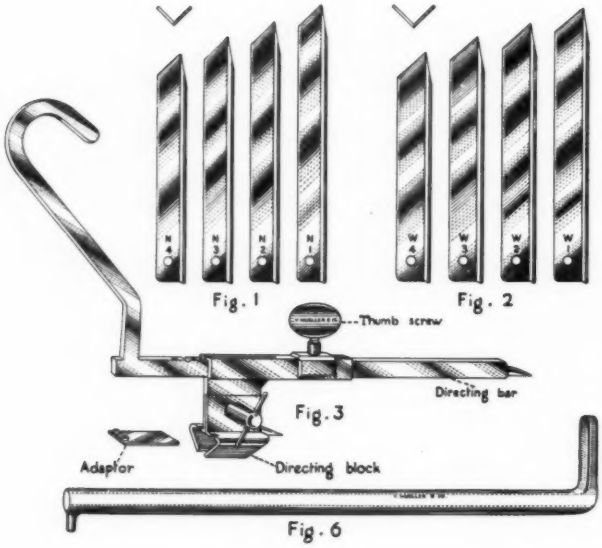
Hustin and Leemans, in 1933, used a rather crude guide for boring a hole into the head, but it was not an instrument of accuracy in any sense of the word. Sterling Bunnell, of San Francisco, also devised a director of almost mathematical perfection and published a description of it in the same year. In 1934, Brocq and Dulot, and Denis described ingenious devices for pegging the neck of the femur which required only a small lateral incision, just large enough to permit a drill, and a small anterior incision over the neck of the femur, which was used to direct it. None of these devices required an extensive arthrotomy.

In 1928, Smith-Petersen devised a three-flanged nail with a head. He made an extensive open arthrotomy and, after alining the fragments of the fractured neck, inserted the three-flanged nail. This method has without question given excellent results and many men have verified the results obtained and published by Dr. Smith-Petersen. However, the difficulty in this operation is that the nail does not always travel in the desired course; in the hands of some operators it has been almost impossible to make the nail take the desired course. It is because of the excessive cost of the Smith-Petersen nail and the difficulty of always directing it correctly that we have been stimulated in our research in an effort to produce a simpler nail or flange which could be used with a director. In our opinion, however, Smith-Petersen's original idea that an arthrotomy is essential to the accurate apposition of the fragments in a case of fractured neck of the femur is fully justified. We find that while certain types can be reduced into almost perfect position by closed manipulation, in other types either a spicule from the proximal fragment or a spicule from the distal fragment has pierced the capsule in such a manner that re-apposition of the fragments into proper position by closed manipulation is utterly impossible. We have been able also to demonstrate, in a certain number of cases, a very definite interposition of the periosteum and synovia detached from either the proximal or distal fragments and dislocated between these fragments in such a manner that it could, without question, prevent union if it were not removed at open operation.

In the spring of 1934, Dr. Ottolenghi, of Buenos Aires, demonstrated a guide or director which he and Dr. José Valls had constructed. This device appealed to our imagination, and upon its basis of construction Dr. Scuderi proceeded to modify the apparatus as here described.

The flanges are made of stainless steel. They embody all of the advantages of the Smith-Petersen nail, from which they have been copied, and, in addition, their utter simplicity of shape and ease of manufacture reduce the cost of manufacture to a minimum (Figs. 1 and 2).

From the Fracture Ward, Cook County Hospital.



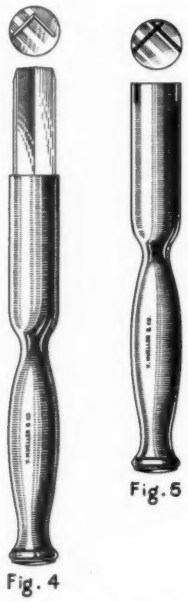


Fig. 1. Four juvenile size flanges, *n*, of varying lengths; 3½, 3¾, 4, 4¼, ⅜ inches in width. The flanges are made of stainless steel.

Fig. 2. Four adult size flanges, *w*, of varying length; 3½, 3¾, 4, 4¼, ½ inches in width, made of stainless steel.

Fig. 3. Assembled director, ready for use, with either width flange.

Fig. 4. Starting chisel.

Fig. 5. Inserter.

Fig. 6. Extractor.

The flanges are made in four lengths, 3½, 3¾, 4, and 4¼ inches, and in two widths ⅜ inch (for the adolescent and the aged women with very narrow femoral necks) and ½ inch (for the average adult with a normally thick femoral neck).

This director was devised with the hope of facilitating the accurate pegging of the fragments —a difficult procedure even when the hip joint has been widely exposed. The director is quite different from the original shown by Drs. Valls and Ottolenghi.

The directing bar has a long sharp prong which is inserted into the anterior lip of the acetabulum, so as to bisect the head. On its top surface are the markings *1*, *2*, *3*, *4*, which indicate the length of nail necessary accurately to peg the head fragment. The directing bar has a handle to stabilize it during its use and to facilitate its handling.

The directing block is manipulated in much the same manner as are the sights of a rifle except that it is movable instead of fixed to the barrel. The directing block keeps the flange in a groove

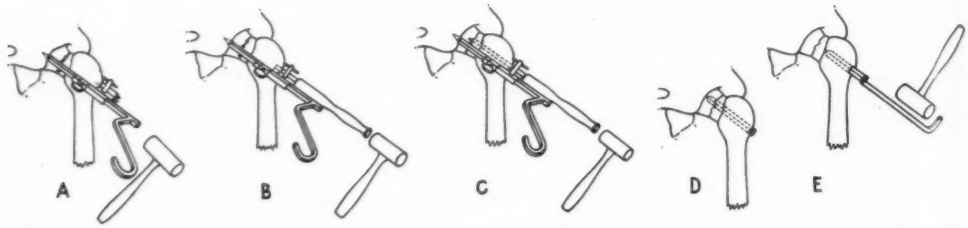


Fig. 7. Set of schematic drawings, showing the various steps in the use of the director, and the accessories. A, Instrument in place ready for use. B, Cutting cortex with the starting chisel. C, Driving in flange with the inserter. D, Dotted lines indicate flange in place. E, Extractor in use.

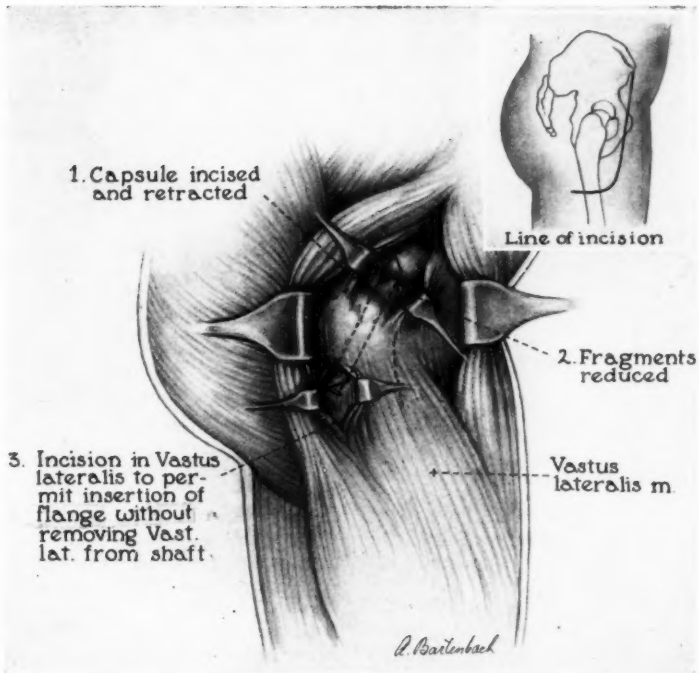

1. Capsule incised and retracted
Line of incision
2. Fragments reduced
3. Incision in Vastus lateralis to permit insertion of flange without removing Vast. lat. from shaft
Vastus lateralis m.
A. Baitenbach

Fig. 8. This drawing shows the line of dissection in an approach to the hip. Although several artistic liberties have been taken in order to portray the details which we desired, in the main the essentials of the exposure are well presented.

so that it must follow the course governed by the directing bar (Fig. 3).

On the front end of the directing block is a sharp prong which is driven into the shaft of the femur just below the trochanteric bulge, so that the flange will travel into the head in a valgus position.

When both the prong of the directing bar and the directing block have been firmly fixed, the thumb screw on the top of the block is tightened so that no slipping can occur. The number of the flange to be used in any specific case is indicated by reading the number on the top of the directing bar. If the specific length of flange indicated is used, one is assured that the flange will be long enough to reach the head of the femur and yet not perforate the acetabulum.

Occasionally the cortex of the femur is very hard and will turn the edge of the flange. A starting chisel (Fig. 4) may be used in such cases to make the original cut in the cortex; the flange will then go in with greater ease and accuracy.

In either the adolescent or an old woman in whom the femoral neck is very thin, a flange of greater width is apt to cause fragmentation of the femur; therefore a narrower flange is recommended. The director is made to accommodate the different flanges; when the narrower flange is used a small metal adaptor is slipped into the directing block to hold it firmly.

The flange is inserted into the directing block and a punch with slotted handle called the inserter (Fig. 5), is fitted over the end of the flange. With a mallet the flange is driven in. The inserter serves three purposes: (1) It prevents the formation of a burr on the hammered end of the flange. (2) After the flange is completely driven in, by means of its shoulder the inserter prevents the holes in the head end from being buried. (3) A few mallet blows on the inserter impacts the fracture surfaces together.

When the flange has been driven about two-thirds of the way in, it no longer can change its course. The director is removed so that the flange

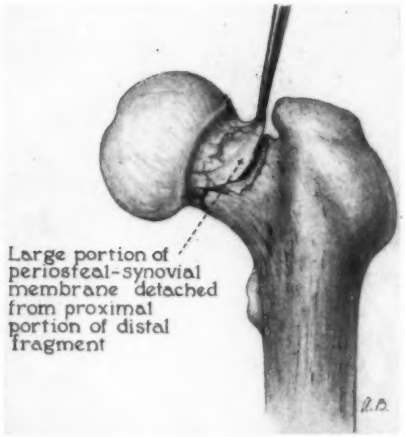


Fig. 9. Detachment of periosteal synovial membrane from the proximal portion of the distal fragment.

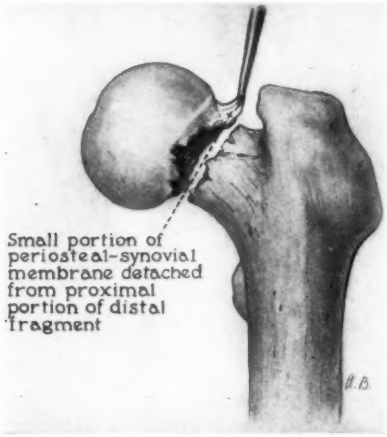


Fig. 10. Fracture similar to that in Figure 9, with small portion detached.

can be driven in the remainder of the way. A thumb release is on the right hand side of the directing block to facilitate its removal if the flange fits too snugly into the block.

Should the flange accidentally be driven incorrectly and one desires to remove it, it can be removed by the use of the simple extractor (Fig. 6). The small prong is inserted through the hole in the flange, and it is hammered out (Fig. 7E).

SURGICAL APPROACH

The incision (Fig. 8) we have found to be the best in these operations has been developed in the anatomical laboratory by Dr. Callahan. The skin incision is made from the anterior superior spine downward toward the knee, for a distance of about 8 inches, and it then dips posteriorly, with a hockey stick curve. The line of cleavage between the sartorius and the anterior border of the tensor fasciæ femoris is then found and this border of the tensor fasciæ femoris is followed until its lower end reaches its fascial attachment. This fascia is then cut transversely and the gluteus medius and tensor fasciæ femoris are retracted posteriorly, while the rectus femoris is retracted medially. At this point, the operator can see the branches of the lateral circumflex femoral vessels, which can be clamped and tied before they are cut. As a rule, there are two or three other small branches which can also be seen and clamped before they are cut. In this manner, an almost bloodless approach to the neck of the femur can be made.

The lateral portion of the rectus femoris and the belly of the iliacus are retracted medially, thus exposing the capsule covering the hip joint. The capsule is then incised in the course of its fibers from the acetabular rim down to its insertion into the intertrochanteric region of the femur. Later, the capsule may be incised as is necessary, but this method preserves the landmarks. The capsule is then detached from its anterior femoral insertion in such a manner that the fragments are exposed and brought into full view.

If the fragments have not been brought into contact by the manipulations previous to the open operation, at this point they are exactly opposed. In this way, the greatest possible area of bone surface is brought into contact.

When the fragments are in exact apposition, a longitudinal incision is made in the vastus lateralis in the direction of the fibers, just below the greater trochanter, and the underlying femur is exposed. The long prong of the directing shaft is now inserted into the edge of the acetabulum (Fig. 7A).

The directing block is then fixed in the shaft of the femur just at or below the bulge of the trochanter major by placing the prong of the directing block through the opening made in the vastus lateralis. This is locked to the directing shaft by turning the thumb screw on its top. The flange is now inserted through the directing block and driven home with the inserter (Fig. 7B).

The capsule is replaced and loosely sutured. The wound is closed with interrupted catgut sutures, and Michel clips or silk sutures are used for the skin. Buck's extension is applied, and the

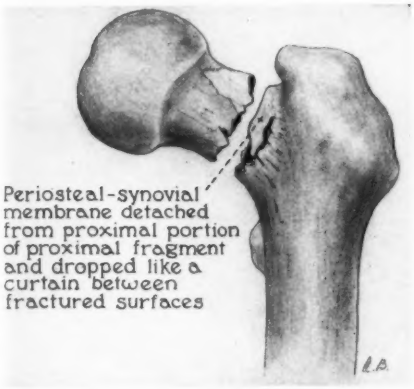

Periosteal-synovial membrane detached from proximal portion of proximal fragment and dropped like a curtain between fractured surfaces

Fig. 11. Reveals curtain between fragments.

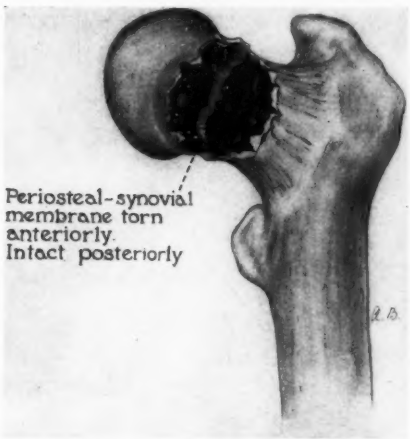


Fig. 12. Fracture with intact, periosteosynovial membrane.

limb is fixed in extension in a Thomas splint. If bed sores or other conditions prevent the patient's lying on his back continuously, it is possible to dispense with the traction and to allow the patient to lie free in bed and be turned to the opposite side or down on the face. The patient is usually returned to the ward, where about 7 to 10 pounds of weight with the limb in extension is used for a period of 10 to 14 days. After this period only thigh extension is used and by means of a Pearson attachment the knee function is resumed. At the end of 3 to 4 weeks all extension is discontinued. Patient then lies flat in bed, and 7 to 10 days later he may be up and around in a walking caliper, which can be removed at night.

When bone growth occurs early, which can be demonstrated with the x-ray, walking on the limb operated upon is permitted at the end of 6 months. But, if no bone growth is evident, longer periods with the caliper are necessary. Usually at the end of 7 to 9 months a bursitis develops over the end of the flange, causing considerable discomfort to the patient. If there is adequate bony union, the flange should be removed. This can be easily done under local anesthesia. In some instances, the flange works itself into the subcutaneous tissues; this necessitates removal.

Our first and most startling observation is that, irrespective of the apparent transverse line of fracture of the neck of the femur according to the x-ray, it is not uncommon to find at the time of operation that there is more or less obliquity. This obliquity is most commonly characterized by a long anterior spicule on the proximal fragment. However, this particular type of obliquity varies in every direction, from above down, from below up, and from before backward. This fact has been emphasized by Dr. Paul B. Magnuson. We have observed other common variations, in which there have been spicules of bone on these fragments, varying in length from ½ to ¾ inch and yet the fragments appeared from the x-ray study to be perfectly transverse.

Another observation which must be carefully mentioned is that the long fragments, particularly when they are on the anterior surface of the proximal fragment, can and do pierce the Y ligament of Bigelow at its middle or at its lower attachment to the femur in such a manner that it is almost impossible to reduce it by any type of manipulation. We have not as yet been able to demonstrate this type of perforation in the posterior portion of the capsule.

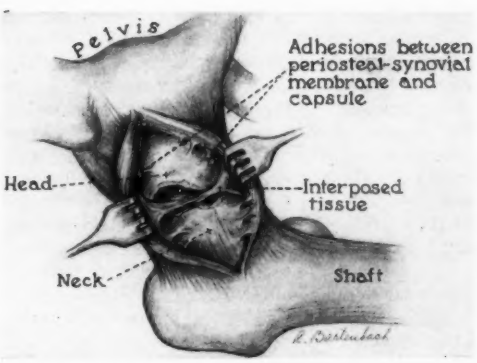
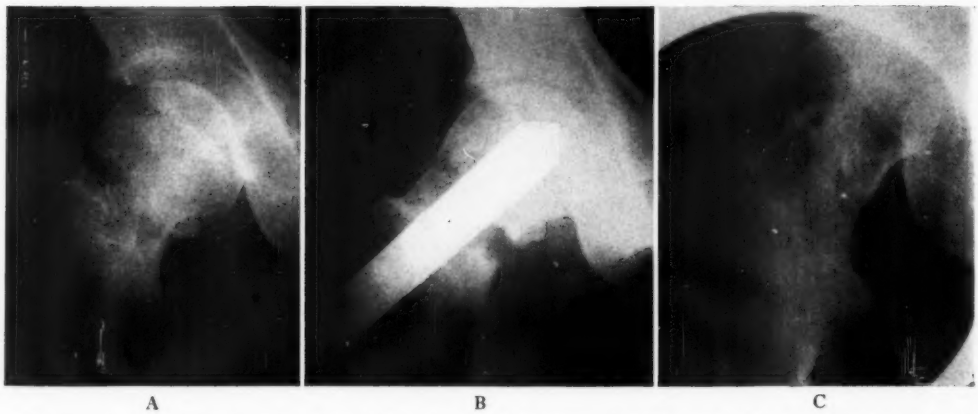


Fig. 13. Typical interposition, as seen in old cases.



A B C

Fig. 14. A, B.C., aged 27 years. Injured August 24, 1935. Roentgenogram shows a transverse subcapital fracture of the neck of the femur apparently in good position. The head appears viable. Operation was performed September 5, 1935. B, Taken September 8, 1935, 3 days after operation. Note an apparent filling defect of the inferior margin of the neck. This was caused by a loss of bone tissue. Patient was discharged from the hospital on October 30, 1935. C, Taken on June 4, 1936, shows the flange removed, and a complete bony union of the fracture line. There has been a filling in of the bone defect, as seen in Figure 14 B. Valgus position has been maintained.

We have also noticed sheets of the periosteum and synovia detached from the proximal portion of the distal fragment (Fig. 9) dropped as a curtain down between the fractured ends of the femoral neck. This same phenomenon has been observed when the periosteal synovial membrane has been detached from the osteocartilaginous line of the proximal fragment and also fallen as a curtain between the fragments (Fig. 10). We also have had 2 cases in which the osteoperiosteal membrane has been completely detached from both fragments and dropped between the fractured surfaces. These pieces of periosteal synovial membrane vary in size from a ribbon shaped piece about ¼ inch wide to a curtain 1¼ inches wide and 1 inch long (Fig. 11).

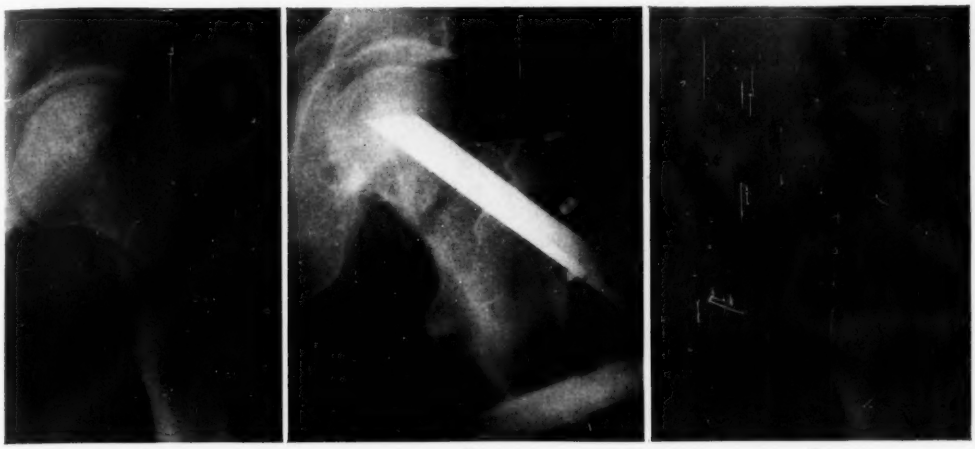
Incomplete fractures of the neck of the femur are not uncommon. We have had four in patients over 60 years of age in whom there was a fracture of the anterior surface of the femoral neck distinctly subcapital, in which there was not a complete separation of the periosteal synovial membrane on the posterior surface of the femoral neck (Fig. 12). In other words, the posterior portions of the fragments had been held in contact by the periosteal synovial membrane.

In 1 patient upon whom we operated late we have every reason to believe that a large curtain had fallen in between the fragments and caused a non-union (Fig. 13).

Regarding the Leadbetter method of reduction of a fractured neck of the femur, we are convinced that when the capsule has been perforated by the sharp spicules, either from the proximal or distal fragment, it is not possible to bring about reduction by any closed method. In fact, in a series of about 35 cases, the reduction in nearly one-half of them was not perfect by any manner of means as we found when the joints were opened by the Callahan incision which revealed the entire anterior portion of the joint.

We have attempted to prove the viability of the head by taking a scoop of the cancellous bone and then having multiple microscopic sections made from this specimen. In some of these there has been an aseptic necrosis of both the head and the proximal portion of the one distal fragment. We are not as yet prepared to state that this aseptic necrosis is not the same type of necrosis which is so common in the ends of all fractured bones. In some sections removed from apparently aseptic necrotic heads, the heads have lived and produced bone.

The amount of blood and blood clots which are found in the joint that is opened in 1 to 2 weeks is an excellent indication of the viability of the proximal fragment. In some joints there is only a small amount of bloody serum, with few, if any, small clots. The microscopic examinations of bone removed from both proximal and distal fragments in these cases have shown a definite aseptic necrosis, or as we prefer to call it "dormant bone," to be present both in the proximal and distal fragments.



A B C

Fig. 15. A, J. L., aged 60 years. Injured May 5, 1935. Roentgenogram shows the position of the fracture after the patient had been in traction a few days. Please note that this is a long oblique fracture with a sharp spicule on both the proximal and distal fragments. B, Patient was operated upon June 19, 1935. This figure shows the position immediately following the operation with the flange inserted. Note the complete change in contour of neck and the impossibility of recognizing the sharp fragments, because they had been accurately reduced. The flange was a little too long for this neck. C, Walking was permitted October 5, 1935. This film was taken January 8, 1936, shortly after the removal of the flange. One can see the groove through the neck of the femur where the flange had formerly been. Close examination shows a complete restoration of the trabeculæ through the neck.

It is not as yet possible to discuss the final outcome of the cases in which this aseptic necrosis has been definitely proved to be present by microscopic examination. This will be discussed in a later communication.

RESULTS

Up to January, 1938, we have operated upon 105 patients with fracture of the neck of the femur. Ninety of these were openly reduced within the first 2 weeks. Fifteen operations were performed from 5 weeks to 6 months following injury. The age of the patients varied from 14 to 82 years; this includes both males and females. Shock did not occur in any of our patients following open arthrotomy. We have had 1 death caused by overlooking a point of infection on the leg, below the hip joint operated upon. In this patient operation was followed by infection and exitus.

There were 3 contracted hips in patients in whom the capsule had been left open. Although these contractions occurred late—1 a convalescing patient with pernicious anemia and the 2 others individuals who developed senile dementia—the possibility that an excessive development of scar tissue in the open capsule might be a cause should be considered.

In 2 cases the femoral head was resorbed following the operation. The flange worked loose and was extruded one-half its length outside of the shaft. The femoral neck in one woman was partially absorbed, but the femoral head was viable, and she has had a painless useful limb, with 1 inch of shortening. We believe these 3 cases must be classed, 2 as failures and 1 as fair, and that they are the result of inaccurate apposition of the fragments or unobserved interposition.

This is a total of 7 unsuccessful results: 1 failure, 1 death, 2 non-unions, and 3 hip contractures. It seems to be true that the early surgical treatment with correct replacement of the fragments has a very favorable effect upon the viability of the femoral head, as up to the present time over 90 per cent of all these early operations have been successful (Figs. 14 and 15). We are convinced, although without microscopic proof, that many so called cases of aseptic necrosis of the head have undergone a rapid creeping substitution, with an early exact approximation of the fragments.

SUMMARY AND CONCLUSIONS

1. We have operated upon 105 patients with no shock and only 1 operative death. The ages of the patients varied from 14 to 82 years, and even though the mortality rate has been low, we have

no illusions as to the inability of aged patients to withstand the shock of any operation.

2. The incision gives excellent exposure with a very small amount of bleeding.

3. The director is of the greatest possible value in accurately approximating and holding the fragments in position, and we are sure that early careful approximation and fixation are of the utmost importance if we are to expect a good growth of bone.

4. Convalescence is much more rapid and the patient is far more comfortable than he has been with any previous method in our hands; in addition he has been saved thousands of bed hours in the hospital.

5. This method has not been so successful in fractures of long duration; in spite of most accurate approximation, in some cases there has not been an adequate amount of bone growth to keep the fragments firmly together. Slipping and loosening in old fractures have occurred, just as with any other method of fixation.

6. Results have been better in those patients in whom we have had a persistent valgus position.

7. The flange is more easily and accurately applied than a screw, and we believe holds more firmly.

8. In 90 per cent of the fresh fractures bony union resulted.

BIBLIOGRAPHY

1. Brocq, P., and Dulot. Presse méd., 42.
2. Bunnell, S. Surg., Gynec. & Obst., 1933, 57: 685–688.
3. Charbonnier, A. Rev. méd. de la Suisse Rom., 1932, 52: 683–691. Lyon chir., 1923.
4. Delbet, Pierre. Quoted from Brocq and Dulot; also Leveuf.
5. Denis, R. Presse méd., 1934, 42: 1954.
6. Hustin, A., and Leemans. Bull. et mém. Soc. nat. de chir. 1933, 59: 740–744. Scalpel, 1933, 86: 1591–1595.
7. Leveuf, Jacques. Fractures of the Neck of the Femur. Monograph, 1927.
8. Smith-Petersen, M., Cave, E., and Vangorder, G. Arch. Surg., 1931, 23: 715–759.

TECHNIQUE OF ANASTOMOSIS USING THE STONE CLAMP

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SINCE the recent publication of the short preliminary article (2) showing the details of construction of a new clamp for performing aseptic end-to-end anastomoses, we have modified the technique considerably and have also used this clamp for lateral anastomoses, end-to-side anastomoses, and for operations involving resection of the stomach. It also works very nicely for the excision of Meckel's diverticula. We feel that we have now had sufficient experience with these various procedures both clinically and experimentally to make a detailed description of the technique of some lasting value. It would seem essential that these details be put before the public as soon as possible because of the spreading use of the new instrument. All of the changes which we have made have been to render the operations less difficult and make them safer. We feel that it is absolutely essential for anybody using this clamp to understand and follow the details of technique as exactly as possible if uniformly successful results are to be expected. For the purpose of exhibiting these techniques in detail we have had prepared a fairly large series of drawings which are published herewith.

Figure 1 shows the mesentery of the small bowel divided down to the marginal vessel which is shown isolated and tied but not yet divided. The actual isolation and tying of this vessel, thereby giving free exposure to the muscle of the bowel wall at the site of the contemplated resection, is quite essential, not only from the viewpoint of giving adequate exposure for the laying of the sutures at a later step, but also for the prevention of damage to the blood supply at the site of the future anastomosis by blind clamping or hematoma formation, either of which at any stage of the operation might so embarrass the blood supply as to make the suture line unsafe. When this vessel is isolated and tied ahead of time, if any such accident should occur, the site of the resection can be readily changed without any loss of time. In choosing the site for the resection it is well if possible to pick a point very close to one of the larger mesenteric vessels so that adequate blood supply is assured. The bowel is crushed with an ordinary Kocher clamp before the application of the resection clamps. The resection clamp is oiled, before being applied, to prevent sticking. A Kocher clamp is placed on each end of the segment to be resected as close to the resection clamp as possible, and the bowel is cut flush against the resection clamp with the actual cautery. If there is disproportion, the clamp on the segment with the smaller lumen can be applied obliquely toward the antimesenteric border in order to increase the size of its lumen.

Figure 2 shows the bowel divided and the segment which was to be resected removed, with the ends of the bowel being brought together for the anastomosis. It will be noted that instead of the clamps having been applied in a line parallel to the mesentery as is the common practice today, they are applied at right angles to it. So far as we

From the Surgical Hunterian Laboratory of the Johns Hopkins Medical School.

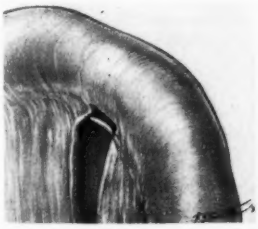

Fig. 1.

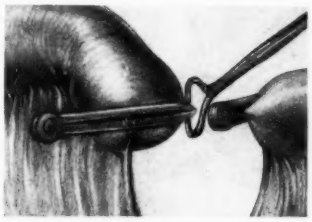

Fig. 2.

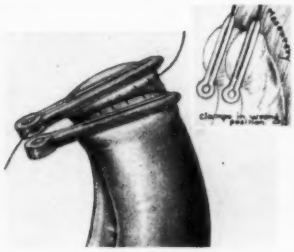

Fig. 3.

Fig. 1. The mesentery is divided down to the marginal vessel which is shown tied but not divided.

Fig. 2. The diseased segment has been resected. The ends of bowel are being brought together for anastomosis; the resection clamp is applied at right angles to mesentery.

Fig. 3. The posterior layer of the continuous silk suture has been laid but has not been completely pulled down as yet. The inset, upper right corner, shows the resection clamps placed parallel with the mesentery which we consider to be the wrong position.

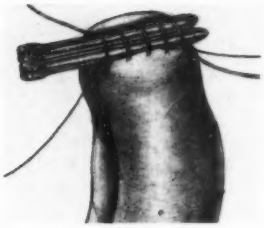

Fig. 4.

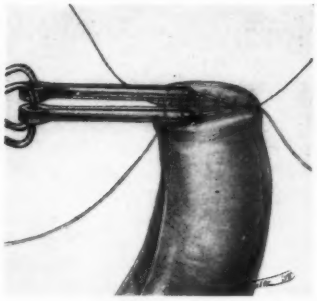

Fig. 5.

Fig. 6.

Fig. 7.

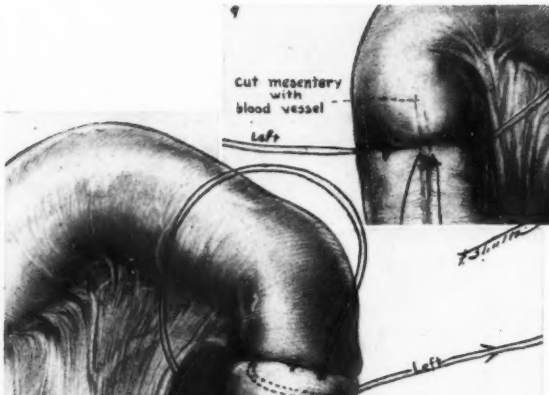

Fig. 8.

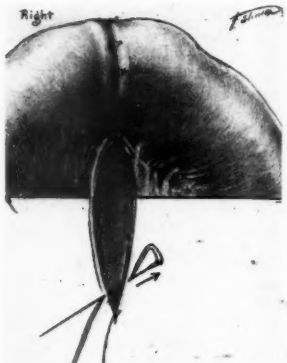

Fig. 9.

Fig. 11.

Fig. 10.

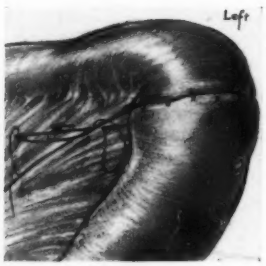

Fig. 12.

Fig. 4. The anterior layer of No. 0 chromic catgut is shown laid. The handles of the clamp have been omitted for the sake of clarity.

Fig. 5. The clamps have been released and are being withdrawn together as the anterior layer is pulled tight to complete the first layer of the anastomosis. Note the application of the handles to the opposite end of the blades to facilitate this maneuver.

Figs. 6 and 7. The beginning of the anterior layer of mattress sutures is shown. The first stitch is used to invert the knot where the catgut has been tied to the silk and is left long for traction as indicated in Figure 7.

Figs. 8 and 9. The method for gaining exposure to the posterior surface of the bowel is shown. One of the sutures which has been left long is passed through the rent in the mesentery, and by making gentle traction in opposite directions on both sutures, the bowel is turned upside down as shown in Figure 9.

Fig. 10. This inset merely shows an enlarged view to emphasize the importance of laying one mattress suture directly at the mesenteric border.

Fig. 11. The anastomosis is shown completed and the rent in the mesentery is being closed. Note that the eye of the needle, instead of the tip, is used for sewing.

Fig. 12. This figure shows the closure of the triangular space at the border of the mesentery on the opposite side from Figure 11.

Fig. 13.

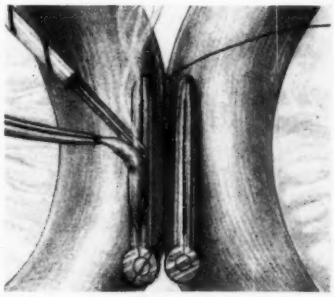

Fig. 14.

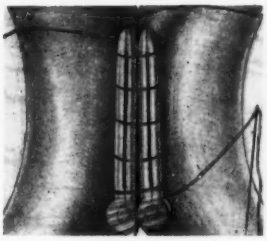

Fig. 15.

Figs. 13, 14, and 15. These three drawings illustrate the method used to perform an aseptic lateral anastomosis. They are self explanatory. The procedure from this point is completed in the same manner as in the end-to-end anastomosis.

know this method of application is new, although it has probably been used many times and never reported. We think that it is a very important step in the technique of doing an end-to-end anastomosis because it gives so much better exposure to the mesenteric border, which is always the hardest point to handle because of the danger of leakage and possible damage to the blood supply. With the clamp placed in this manner the bowel wall can be exposed down to the muscle and the suture lines laid to the desired depth without danger. If one is using the clamp for a Parker-Kerr type of inversion, this method of application is also of great value because it places the mesentery in the center of the clamp where it is easy to invert instead of at the tip where it is next to impossible to invert. This technique is being taught the Hopkins students, but we have never seen it pictured or described in any of the current textbooks or systems of surgery. One of us (Owings) started to teach this method in 1927.

Figure 3 shows the posterior line of continuous silk laid but not yet pulled down tight. The handle of the clamp has been omitted for the sake of clarity. The inset in the corner is merely made to emphasize the common way of applying the clamps which we consider to be the wrong way. It shows the clamps placed parallel with the mesentery, the mesentery being held in the tip of the clamp.

Figure 4 shows the posterior layer of silk pulled down and tied and the anterior layer of No. 0 or No. 00 chromic catgut laid over both clamps but not yet pulled down. We are using chromic catgut in this anterior layer instead of silk for two reasons: first, it is stronger, and, second, it slides more smoothly. Silk has a tendency to grab and because of this to pull down tight at both ends leaving the middle loose and improperly inverted. Chromic catgut overcomes this difficulty.

In Figure 5 the clamps have been released from the crushed edge of the bowel and are being withdrawn together. The handles of the clamps have been removed from the tip and placed on the hinge to facilitate this procedure. The anterior suture of catgut is being pulled down as the clamps are withdrawn to complete first layer of anastomosis.

In Figure 6 the posterior layer of silk has been tied to the anterior layer of catgut, but was first tied on itself to prevent any possibility of purse-string action. The anterior row of mattress sutures has been started. This layer is always started at the corner so as to invert the knot and is left long to be used as a traction suture. The mattress sutures must be *narrow* in order not to strangulate too much tissue.

Figure 7 shows the anterior row of mattress sutures completed with the two corner ones left long. The average anterior layer would contain 6 or 7 sutures, but only 4 are shown here for the sake of clarity.

Figure 8 shows the method used to get exposure to the mesenteric border. The end of one of the

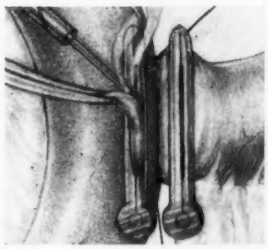

Fig. 16. This drawing illustrates our method of performing an end-to-side anastomosis aseptically. From this point, the operation is done in the same manner as it is done in the end-to-end procedure.

two mattress sutures which have been left long is carried through the rent in the mesentery and by applying gentle traction the bowel is turned upside down as shown in Figure 9. Figure 9 also shows the posterior line of mattress sutures partially laid. Two more would ordinarily be laid where the posterior layer of silk is still showing. We always make a point to put one suture right at the mesenteric border to insure good co-aptation at this point, as better illustrated in Figure 10 where the suture has not yet been tied. Figure 11 shows the bowel turned back into normal position with the external layer of mattress sutures completed. The mesentery is treated in one of two manners. Usually it is closed by direct co-aptation, care being used to close the triangular space in the exact position it was before it was divided. Sometimes the mesentery is overlapped as suggested by the Mayos (1). The rent in the mesentery is closed by a very carefully placed continuous suture of silk shown beginning in Figure 11. The closure of the small triangular mesenteric space on the opposite side is illustrated by Figure 12. It will be noted that the eye instead of the point of the needle is used for sewing to prevent damage to the mesenteric vessels.

Figures 13, 14, and 15 show the technique of performing a lateral anastomosis aseptically with the same instrument. Figure 13 shows the bowel brought together with the portion to be resected bulging through the blades of the clamp. In Figure 14 the posterior layer of silk has been laid and tied, and the bowel wall has been cut away with cautery on one side and is shown in the process of excision on the opposite side. Figure 15 shows the method of laying the anterior row over both clamps. From this point on the anastomosis is completed in exactly the same manner as shown for the end-to-end anastomosis, the final layer in each instance being a row of mattress sutures. Access to the posterior wall can be gained in the same manner also. About the only situation in which this operation is not feasible is when one encounters a very narrow terminal ileum, making resection of a portion of the bowel wall dangerous because of the consequent further narrowing of its lumen. In this case we still use the old open method of anastomosis.

Figure 16 shows the same method applied to an end-to-side anastomosis. The posterior layer of silk has been laid and tied and the segment of the bowel wall to be used for the lumen of the anastomosis is shown in the process of excision. From this point onward the operation is done in exactly the same manner as previously shown in the technique for end-to-end anastomosis.

We feel that this clamp has certain very definite advantages over the previous instruments used for this purpose. It has a very narrow blade which, therefore, crushes very little tissue and consequently produces a very narrow cuff, thereby obviating the liability of diaphragm formation which has been one of the dangers in all of the older methods. In spite of this narrow blade, its strength and longitudinal grooves, together with the fact that it crushes evenly throughout its length, prevents any possibility of its slipping off and thereby soiling the field of operation. The fact that the handles are adjustable to right angles and the blades very short allows the instrument to be used in deep positions such as low in the pelvis where it would be impossible to work with any other type of instrument. Because of this fact a good many patients have been saved from a complete abdominoperineal operation. It is so simple and easy to handle that it saves a great deal of time, which is particularly important in this type of operation. It makes it easy to do aseptic end-to-end, lateral, and end-to-side anastomoses. We have used a somewhat larger model of the same clamp for stomach resections using the same closed aseptic technique. However, we had one case of severe hemorrhage and, therefore, are somewhat doubtful as to the wisdom of using the instrument for this operation since it is impossible properly to control the large vessels in the stomach wall when sewing more or less blindly. We have found it quite useful for the inversion of the duodenum, however, because it destroys so little tissue and is easy to work with down in this more or less inaccessible region. The Parker-Kerr method of inversion is used and reinforced with a layer of mattress sutures.

REFERENCES

1. Mayo, C. H. Ann. Surg., 1933, 98: 834–838.
2. Stone, H. B. Surg., Gynec. & Obst., 1937, 65: 383–384.

THE MODERN TECHNIQUE OF SUBTOTAL THYROIDECTOMY

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IT is my purpose here to gather together into a synthesis the complete ensemble of pre-operative, operative, and postoperative treatment that has raised thyroidectomy from the status of a terrifying surgical specter to that of a safe and almost bloodless procedure with a mortality of less than one-fourth of 1 per cent in the hands of experienced surgeons, and a procedure having to its credit the restoration to health and usefulness of many thousands of unhappy toxic goiter patients.

I should like to stress what seems to me the importance of encouraging a greater number of general surgeons in localities remote from special thyroid clinics fitting themselves to carry out the technique of this modern operation. It will always be true that large clinics specializing in the surgical treatment of goiter are indispensable in this age of terrific nervous wear and tear, and that these centers can furnish the best care to patients able to remain indefinitely in the neighborhood for observation and treatment until cure is complete (often a long, slow process). The fact remains, however, that a substantial number of patients have to travel a long distance to reach one of these goiter centers, and that, for economic reasons, they can remain under the observation of the clinic for but a limited time. Large numbers of these patients must, far too soon, return to their own community and to the care of a clinician who has not the specialized understanding and experience of these cases.

How little the word of a thyrotoxic patient is worth in response to follow-up letters from the clinic, has been emphasized by Miller. His answer will be no true index to his degree of recovery. Such a patient will say he feels fine, though his pulse may be running wild as he writes. All these patients require the frequent examination of one who understands thyroid behavior and can determine to what degree the operation has been a success. Was sufficient thyroid tissue removed? Was too much tissue removed? Is further operation necessary? Or is the patient now a hypothyroid? Does he require thyroid extract? To answer these and other similar questions the presence on the spot of the surgeon who did the operation is highly desirable. It may even be the determining factor in the patient's complete recovery.

From the Department of Surgery, De Courcy Clinic.

It is unfortunately true that the great mass of the medical profession has a very imperfect conception of the requirements of these patients. The importance of correct postoperative care is so great that, if the operation and its follow-up treatment can be in the hands of one and the same surgeon for months or years, the advantage to the patient is immeasurable. It is possible for any surgeon of wide general experience to establish a competent thyroidectomy technique and to carry it out with an absolute precision which eliminates the risk of unexpected complications. It is the surgeon of this class that I have in mind in presenting this paper.

PRE-OPERATIVE PREPARATION

One should never be in a hurry about operating upon a thyrotoxic patient. The first prerequisite is rest of mind and body. In most of these cases the patient has been suffering for months or years with a sense of inability to bear the burdens that life presents. The mind has been in a state of worry, the body in a state of tension. The nerves and heart have reacted unfavorably.

If the case is one of only moderate hyperthyroidism, the patient may be allowed to sit up in a chair for a part of each day and even to take short walks about the hospital or its grounds. In more severe cases the patient is put to bed and kept there strictly for several weeks. In any case, the patient must be in the hands of cheerful and understanding physicians and nurses, who are equipped to maintain morale and to minimize the tendency to worry about domestic, financial, or other troubles. The patient's confidence must be gained and his fears with reference to the operation allayed. The hyperthyroid patient is always a hypersensitive individual and has a capacity for suffering that is absent from those who are built on a more phlegmatic pattern.

The diet must be carefully chosen to provide approximately 5000 calories per day. This high caloric diet must consist of materials easily digested and should contain a large amount of sugar to insure a good storage of liver glycogen. Candy

may be permitted *ad libitum*, unless there are diabetic complications. Meats are not prohibited, but must not be given in too large amounts. Fluids are given in large quantities, up to 3 to 4 liters a day. If edema appears due to the cardiac conditions, fluid is decreased until the heart function shows signs of becoming normal again. In rare cases hypodermoclysis may have to be employed, if there is intolerance of fluids by mouth.

Most important among medical measures is the administration of Lugol's solution for 2 to 4 weeks previous to operation. It is now some 15 years since Plummer of the Mayo Clinic introduced the use of this compound iodine solution (free iodine 5 per cent, potassium iodide 10 per cent, in 100 cubic centimeters of water) in treatment of hyperthyroidism. This has the effect of causing rapid involution of the hyperplasia and of reducing the goiter to a colloidal state, in part at least, thus making its removal easier and permitting greater thoroughness in operation. Its use has lessened the hazards of operation to a marked degree and has been one of the most important factors in eliminating the two to several stage operation formerly in almost universal use.

At the De Courcy Clinic all goiter patients, as a matter of routine, receive 10 minims of Lugol's solution 3 times a day for 2 to 4 weeks previous to operation, the time depending on the degree of clinical improvement observed and on the changes occurring in the gland itself as checked by metabolic readings. The immediate effects consist of relaxation of nervous tension, a control of toxic symptoms, a fall in the basal metabolic rate of 2 to 4 points daily, and increase of appetite and a sounder sleep. This improvement is only temporary, however, and must not be taken to indicate that operation has become unnecessary.

Boothby has shown in a series of graphs that the introduction of iodine previous to operation caused a drop in operative mortality from between 3 and 4 per cent to less than 1 per cent and reduced the number of stage operations from 50 per cent to 2 per cent, permitting subtotal thyroidectomy in a single operation to take their place.

The earliest moment of full iodinization is not necessarily the optimum time to operate. The time of operation should be chosen on the basis of the patient's condition and not on any basis of a fixed time after the beginning of iodine administration.

For toxic thyroid patients, who exhibit severe signs of heart failure, thorough digitalization should be brought about. Patients are put to bed and given from 5 to 10 drops of tincture of digitalis 3 times a day, according to the degree of decompensation. This is usually discontinued 5 days before the operation. In these cases, if edema is present, fluids are restricted to not over 1 liter a day. In very severe cases preliminary blood transfusion may be a necessary prophylactic measure. Sedation must of course be administered to patients in a state of great nervous excitement. The pre-operative use of iodine is doubly important in cases of patients in whom a psychosis is present, in view of the danger of its exacerbation immediately after operation.

The ideal time for operation is found when nervousness is overcome, weight either stationary or gaining, pulse rate below 100, and the basal metabolic rate less than plus 40. I feel that no operation should ever be undertaken while weight is still falling, since this means that catabolism overbalances anabolism and that, consequently, the thyroid function is too active for surgery.

In extremely toxic cases, or those patients in whom there is an excessively large goiter, it is sometimes still necessary to do a two stage operation, especially if the patients do not improve under iodine medication.

IMMEDIATE PRE-OPERATIVE PREPARATION

The patient receives a soapsuds enema on the evening before operation. By mouth 30 minims of Lugol's solution is administered at this time. Appropriate sedation is given to secure a good night's rest. The following morning $^1/_8$ to $^1/_6$ grain of morphine is given 1 hour before operation. This enables the patient to approach the time of operation in the perfect peace of mind that is indispensable for the best operative results. Rather liberal premedication is desirable to lessen the inevitable nervousness and excitement incident to the approaching ordeal in this type of patient.

ANESTHESIA

Since 1920 approximately 9,200 goiter operations have been performed at the De Courcy Clinic under various methods of anesthesia. After a thorough trial of local anesthesia in 500 cases, and of ether and a number of other methods, we have given all of these up in favor of nitrous oxide and oxygen, which we began to use in 1925. Among its many advantages are the rapidity with which it takes effect, the promptness of recovery, and the easy regulation of dosage. With this type of anesthesia it is possible to deepen or lighten at will the degree of narcosis. Postoperative vomiting is infrequent and postoperative hemorrhage very rarely occurs.

The chief disadvantage of local anesthesia, which is favored by many on account of its lack

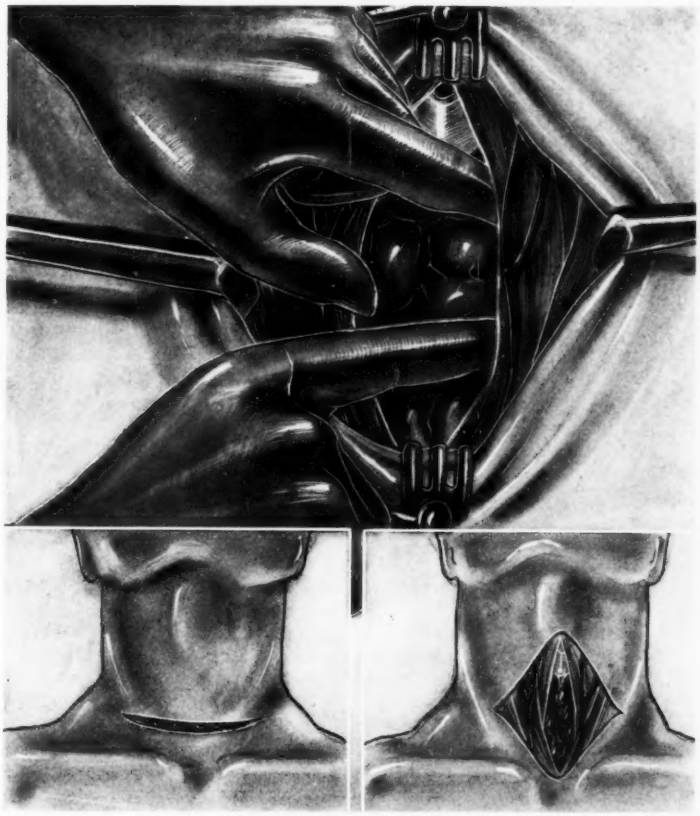

Fig. 1. Lower left, incision through skin and platysma.
Fig. 2. Lower right, longitudinal incision of fascia.
Fig. 3. Above, freeing of gland from overlying structures.

of toxicity, lies in the fact that these patients, being very nervous and excitable, often cannot tolerate an operation done while they are in a conscious state. In addition, local anesthesia has often been found inadequate during the stage at which the lateral lobes of the gland are elevated, and the surgeon on the whole has less freedom for rapid manipulation.

Because of the frequency with which a damaged myocardium is present in these operations, an efficient airway is a *sine qua non* for their execution. This is best secured by the free flow of oxygen obtainable under nitrous oxide combined with oxygen, which can be given in any proportion desired and varied from one moment to another according to need.

OPERATIVE TECHNIQUE

1. With the patient in the recumbent position, the incision is usually made in one of the lower creases of the neck. It should, however, not be so low as to sag down at a later time below the natural lowest skin crease. Too much curvature is to be avoided. The knife should be drawn across the neck with an arm motion, which does not bend the hand at the wrist, so as to prevent a feathering of the skin margins and thus to permit a better connective result. The incision should be carried through the closely adherent platysma to facilitate blunt dissection (Fig. 1).

Small bleeders or oozing spots in the skin flap are grasped with small hemostats and coagulated. This eliminates ligation which frequently becomes

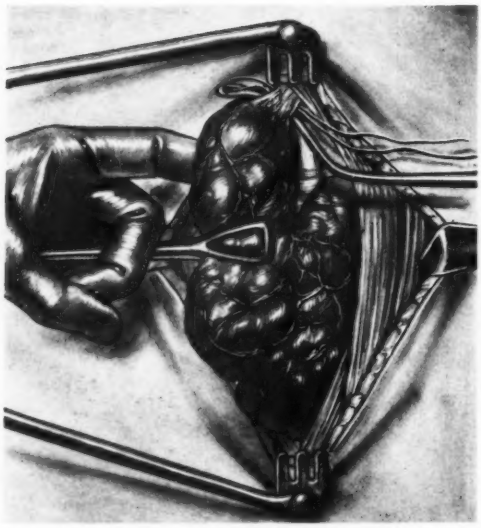

Fig. 4. Ligation of superior pole.

noticeable later because of cystic accumulation about the catgut.

Care should be taken to cut in the fascial plane between the platysma and fascia on the anterior surface of the ribbon muscles. In order to avoid severing the cutaneous nerves, which would result in later numbness and in paresthesias that sometimes occur from the chin downward, the skin flap should not be raised laterally more than just enough to make a V between the lateral ends of the incision and the highest point of the midline.

2. It is seldom necessary or desirable to sever the ribbon muscles; but, in the hands of a less experienced operator, such a division may for a time be the safer course until greater proficiency is gained. In such case, the division should be made high up and as near the larynx as possible in order to reduce the possible damage to the nerve supply of the upper portion of the muscle. After experience has been gained, sufficient visualization is obtainable if the longitudinal incision of the fascia is carried well up over the laryngeal cartilage (Fig. 2). Previous to the days of iodinization, it was difficult to raise the hyperplastic gland and therefore necessary to divide the ribbon muscles.

Occasionally today we divide the muscles in very large substernal goiters or in those which, because they are iodine fast, fail to undergo colloid involution. These indications are, however, relatively rare.

3. Blunt dissection over the gland with the fingers facilitates delivery. No attempt is made to go around the gland, because in doing this there is danger of tearing the lateral vein and also of traumatizing the recurrent laryngeal nerve (Fig. 3).

A definite strip must be left on each side toward the back of the gland, in order to preserve intact the parathyroids and the recurrent laryngeal nerve. If by chance a parathyroid is damaged, the accidentally dissected gland should be immediately re-implanted. One should avoid the removal of any fat-like processes, since the exact position of the parathyroids is not always predictable. In the event of injury to the laryngeal nerve, revealed by a change in the type of breathing, the nerve should be repaired at once; if it is cut, it must be sutured. If a clamp is making pressure upon it, it must be removed.

4. Elevation of the right lobe can usually be accomplished to a point sufficient to apply the traction forceps by use of a mouse-tooth tissue forceps. After applying this and elevating the lobe with the traction forceps, the sternothyroid muscle, which is adherent to the side of the gland, is wiped down with a piece of gauze as the lobe is being elevated.

5. The superior pole is next dissected free and a double strand of No. 2 chromic catgut passed above the pole and tied; thus the superior artery is secured. Before the carrier is passed around the pole, the latter is elevated by passing the finger underneath and raising it (Fig. 4).

Because of the close proximity of the superior laryngeal nerve, some surgeons feel that it is necessary to dissect out the superior artery and tie it under direct vision.

In doing a number of dissections on the cadaver, I have found this to be unnecessary and undesirable for two reasons. First, the artery frequently divides some distance above its entrance into the gland and there is some danger of injuring the nerve because of the added trauma. Second, because of the poor exposure at this point, retraction of the artery frequently occurs after the clamp is applied and makes ligation not only difficult but also hazardous, besides encouraging slipping of the knot with primary or secondary hemorrhage.

If the finger is passed under the superior pole and the pole is raised, the carrier is passed only around the vessels and there is no danger to the nerve or the trachea. In the examination of 10 cadavers ligated in this manner with subsequent inspection, the superior laryngeal nerve was not included in the ligation once.

Fig. 5. Stripping right lobe across trachea.

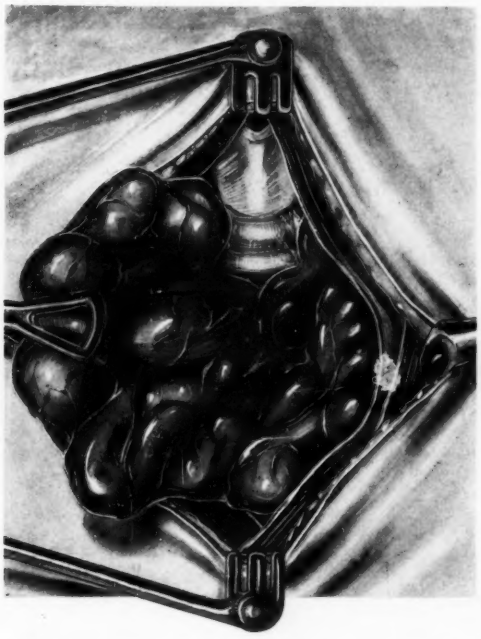

Fig. 6. Elevation of left lobe by traction upon right lobe after trachea has been dissected free.

6. After elevation of the right lobe and ligation of the superior artery, the superior pole is incised with a knife proximal to the ligature. This incision facilitates further elevation of the gland and permits a more even dissection, thereby lessening the chance of leaving too much glandular tissue at the superior pole, which would favor a recurrence at this site.

Straight mouse-toothed hemostats are applied along the side of the gland at right angles to the trachea. These hemostats clamp the branches of the inferior artery and veins as they penetrate the gland. The trunk of the inferior artery is not exposed. I still feel that the ligation of this trunk lessens or entirely destroys the blood supply to the parathyroid bodies and encourages tetany.

The amount of gland to leave is always a controversial question. It is better to remove too much than too little, because the remaining portion will usually hypertrophy to a point sufficient to maintain normal body metabolism. As a rule, in my opinion, not less than four-fifths of the gland should be removed if thyrotoxicosis is to be relieved; but, of course, the amount varies with the individual case. A practical way is to place the hemostats so that they will lie on a plane with the anterior surface of the trachea if the gland is elevated at the time the clamps are placed.

7. The right lobe is then dissected from without inward until the trachea is reached. The surgeon then usually disregards the right lobe and proceeds to dissect the left lobe, leaving the trachea until the last.

Instead of doing this, I continue the dissection of the right lobe right across the trachea and slightly under the left lobe. When the trachea is reached, a little traction discloses a line of cleavage, and dissection of the isthmus is greatly facilitated without damage to the trachea (Fig. 5).

8. After the trachea is crossed, traction upon the right lobe and isthmus automatically lifts the left lobe from its bed and in this way eliminates the trauma which is sometimes required during the effort to raise the left lobe. By this method it is usually possible to elevate both lobes with thumb forceps only (Fig. 6).

9. After subtotal thyroidectomy the clamped vessels are ligated individually with No. 2 chromic gut. If it is thought necessary, some of the sutures may be anchored. No attempt is made to close

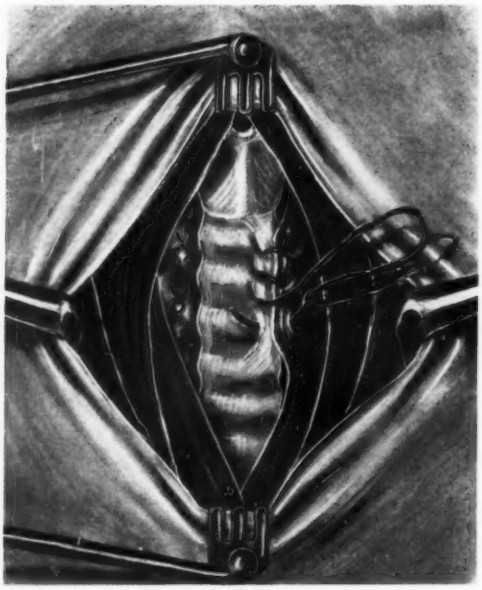

Fig. 7. Suture of sternothyroid muscle to pretracheal fascia.

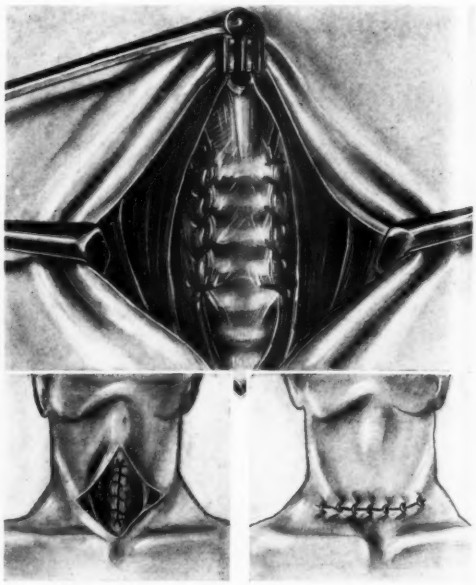

Fig. 8. Above, sternothyroid muscle sutured to pretracheal fascia.
Fig. 9. Lower left, longitudinal incision of fascia sutured.
Fig. 10. Lower right, skin incision closed.

over the anatomical capsule of the gland. Instead, the sternothyroid muscle is sutured on either side to the pretracheal fascia with No. 0 plain catgut (Fig. 7). This muscle not only acts as a hemostatic agent over any seepage from the gland surface, but prevents any overlying adhesions to the gland itself as well.

Since we have been doing this, we have eliminated drainage in all but the very exceptional case in which a large cavity remains after removal of the substernal goiter.

In our last series of 2,000 cases we have not drained thyroidectomy wounds with very few exceptions (less than 1 per cent), and have thereby lessened the convalescent period very perceptibly.

10. The ribbon muscles are next sutured vertically and the skin closed with clips, to be removed in 72 hours (Figs. 8, 9, 10).

The principal accidents to be guarded against are hemorrhage, injuries to the parathyroids or to the recurrent laryngeal nerve, collapse of the trachea, and air embolism through the large veins of the neck. If a scrupulous technique is observed, none of these is likely to occur. In the event of a collapse of the trachea, tracheotomy must be done instantly.

POSTOPERATIVE CARE

The postoperative treatment of goiter cases has been tremendously simplified since the introduction of pre-operative iodine treatment. In most cases there is immediate improvement, consisting of relief of tachycardia, muscular tremor, restlessness, and fever.

The patient is put to bed in a comfortable position and watched closely for complications. Lugol's solution is as useful after operation as it was before. In the average case the patient receives 10 minims every 8 hours, beginning as soon as he is back in bed. In all toxic cases, however, he is given 30 minims by rectum upon his return to bed, and this is repeated 8 hours later; in rare cases, a third large dose is given. Fluid is administered subcutaneously, and may be taken by mouth if there is no vomiting. Application of warmth and administration of sedatives are necessary. Oxygen may be required, and the oxygen tent should be in readiness for such emergency.

In cases of extreme prostration transfusion may be necessary. In the event of a thyroid crisis—now, happily, a rare occurrence since the introduction of Lugol's solution pre-operatively—iodine

and quinine hydrobromide are immediately given with intravenous glucose, oxygen, and refrigeration. If signs of tetany occur, parathyroid Collip extract and calcium lactate should be in readiness. In the average patient, however, none of these emergencies arise and the patient makes an uneventful recovery.

AMOUNT OF GLAND TO REMOVE

The question of how much thyroid tissue to remove is far from being purely academic.

If too little is removed, the result is a continuance or recurrence of thyrotoxicosis. Many patients will never be persuaded to undergo a second operation, even though it be greatly needed. In such cases it is important to do a radical operation from the start. If, through fear of giving rise to myxedema, too little gland is removed, it may be impossible ever to persuade the patient to return again. This should impress upon us the realization that an ineffective operation means a defeat to surgery.

On the other hand, the removal of too much thyroid tissue invites myxedema, which may involve personality changes. The general consensus is that too much should be removed rather than too little, since the probability is that the gland will grow again to some extent and will thereby replace lost tissue, and thus myxedematous changes will be prevented.

Lahey, who has given close attention to this problem, concludes that a correct decision can be made on the basis of the degree of involution that has been brought about before operation by Lugol's solution. In the case of patients on whom this iodine involution is of high degree, as judged by gross appearance (pale, edematous tissue), he would remove relatively less tissue, in order not to impair the reproductive ability of what is left, which is now small. In patients in whom involution is of low degree, with a brownish red and cellular appearance of the tissue, he would remove a large quantity, lest its reproduction be too easy, resulting in return of excessive thyroid activity.

According to Pool and Garlock, there seems little doubt that the occasional thyroid surgeon, not a specialist, will have a high recurrence rate, because of inadequate removal of this gland. He is afraid of injuring the parathyroids and the laryngeal nerve, and in addition he has not yet developed a standard procedure. He may therefore expect many recurrences before he has learned to operate efficiently and adequately in this disease. Pool and Garlock themselves report a recurrence rate of 9 3 per cent in a series of 171 primary resections.

My own conviction is that it is much better to remove too much than too little of the thyroid gland, since we have very good means now of combating hypothyroidism by thyroid feeding, whereas hyperthyroidism can thus far be overcome only by surgical means. As already pointed out, the patient is with difficulty persuaded to return for repetition of a procedure that has already failed to bring relief.

SUMMARY

1. It was chiefly the arrival of the artery clamp that made possible the modern surgical treatment of goiter.

2. General surgeons should equip themselves more generally to perform this important operation.

3. The surgical technique of subtotal thyroidectomy is presented.

4. It is safer to remove too much than too little of the hyperplastic thyroid gland.

BIBLIOGRAPHY

1. BOOTHBY, W. M. Disease of the thyroid gland; interpretative review of progress toward solution of problem. Arch. Int. Med., 1935, 56: 136–206.
2. DIEFFENBACH, J. F. Die Operation des Kropfes. Die Operative Chirurgie, Leipzig, 1848, pp. 331, 340.
3. Gross, S. D. A System of Surgery, Vol. 2, 4th ed. Philadelphia, 1866, p. 394.
4. HALSTED, Wm. S. The Operative Story of Goitre, In: Johns Hopkins Hosp. Rep., 1920, 19: 71–258.
5. LAHEY, F. H. How much thyroid tissue should be removed in toxic goiter? Ann. Surg., 1932, 95: 529.
6. LISTON, R. Lectures on the Operations of Surgery and on Diseases and Accidents Requiring Operations. Philadelphia, 1846, p. 318.
7. MILLER, C. C. Safeguarded Thyroidectomy and Thyroid Surgery. Philadelphia: F. A. Davis Co., 1928.
8. PLUMMER, H. S. Results of administering iodine to patients having exophthalmic goiter. J. Am. M. Ass., 1923, 80: 1955.
9. POOL, E. H., and GARLOCK, J. H. Surgical treatment of exophthalmic goiter; late end-results. Surg., Gynec. & Obst., 1934, 59: 330.

A STUDY AND END-RESULT REPORT OF SEVENTY ARTHROPLASTIES AND RECONSTRUCTION OPERATIONS ON THE HIP JOINT

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A STUDY has been made of all the arthroplasties and reconstruction operations of the hip joint that have been performed at the New York Orthopedic Dispensary and Hospital from August, 1916 to October, 1934.

Seventy-five operations have been done on 71 patients. In 2 of the patients, a second mobilizing procedure was done on the same hip; and in 2, bilateral operations were performed but at different times.

Five patients were followed for less than 1 year for reasons outside of our control. This leaves 70 operations in which there has been a follow-up examination of 1 year or more. The longest follow-up time was 12 years and the average was 3.5; expressed as case-years, the average time was 4.

No selection of patients for operation was made, provided that there were present severe enough symptoms to warrant major surgery and that the cause of the disability was such as to make a mobilizing procedure proper. In many the degree of joint damage was staggering, such as complete destruction of the head and neck and dislocation of the femoral shaft upon the ilium, or tremendous overgrowth and deformity of the head with degeneration of cartilage and obliteration of the joint space. By operation it was hoped to give these distressed patients stable hips that were free from pain and that had adequate ranges of mobility.

ETIOLOGY

The cases were divided according to history and x-ray findings into the following groups: osteo-arthritis, 18 cases; osteo-arthritis following trauma without fracture, 2; osteo-arthritis following fracture, 3; osteo-arthritis following non-specific synovitis, 1; rheumatoid arthritis, 2; infectious arthritis, 2; arthritis or ankylosis due to the gonococcus, 3; residual adolescent slipped epiphysis, 6; residual coxa plana or magna, 8; fibrous ankylosis following operative procedures, 3; stabilization of old congenital dislocation of the hip, 1; ununited fracture of the femoral neck, 1; residual suppurative arthritis, 20; a total of 70 cases.

The 3 cases of osteo-arthritis resulting from fracture followed a compression fracture of the upper portion of the femoral head, a fracture of the acetabulum with posterior dislocation of the hip, and a fracture of the neck with malunion.

The 2 cases of infectious arthritis followed respectively scarlet fever and phlebitis. Suppuration did not occur.

The gonorrheal cases included 2 with fibrous and 1 with bony ankylosis.

The 3 cases of fibrous ankylosis following operations resulted from open reductions, 2 for congenital dislocation of the hip, and 1 for adolescent slipped epiphysis.

The 20 cases of residual suppurative arthritis are from the standpoint of therapy a formidable group. Half of them presented dislocation following destruction of the femoral head and neck, and 3 had bony ankylosis. One case, thought to be pyogenic in origin, was proved later by microscopical section to be tuberculous. In this patient fusion has been obtained and an excellent result with complete subsidence of the disease.

AGE AND DURATION OF SYMPTOMS

The ages of the patients at operation varied from 18 months to 66 years. The average was 29 years.

The duration of symptoms prior to operation ranged from 18 months to 26 years and averaged 6 years.

SYMPTOMATOLOGY

The patients complained of pain, limitation of motion, instability, deformity, and shortening.

Pain. Fourteen patients had no pain before operation: 6 of these suffered dislocations, 1 was only slightly over 2 years of age and had almost a dislocation (residual suppurative arthritis), 4 had bony ankylosis, and 3 had fibrous ankylosis that allowed slight or no motion at all.

Four patients had pain estimated as 1 plus in severity (scale 0 to 4 plus); 12, 2 plus; 26, 3 plus; and 10, 4 plus. No pre-operative note was made in 4. The average amount of pain was 2 plus.

From the New York Orthopedic Dispensary and Hospital.
Read at the annual meeting of the American Academy of Orthopædic Surgeons in Cleveland, Ohio, January, 1937.

Limitation of motion. In order to express completely and simply the entire range of mobility present in any given hip joint, the index of function was employed that was described by Ferguson and Howorth.[1] To obtain this index, the degrees of motion present in each arc of mobility are multiplied by a suitable factor, the size of which depends upon the relative importance of that particular arc for function of the hip as a whole. The products are added and the sum is the index of function. The factors chosen were: for flexion 0.4; for extension 0.1; for abduction 0.4; for adduction 0.2; for internal rotation 0.2; for external rotation 0.1. The normal hip has an index of from 90 to 110. Table I is an illustration.

TABLE I.—EXAMPLE

Arc of motion	Degree of motion	Factor	Product
Flexion	145	0.4	58
Extension	10	0.1	1
Abduction	45	0.4	18
Adduction	30	0.2	6
Internal rotation	30	0.2	6
External rotation	60	0.1	6
Index of function			95

EXPRESSED IN GENERAL TERMS

	Degrees
Hypermobile	Over 110
Normal	90–110
Good	60–90
Fair	50– 60
Indifferent	40– 50
Poor	30– 40
Bad	Under 30

Excluding for reason of simplicity, the patients with dislocation (13, 12 before operation and 1 after), the index of function before operation ranged from 0 to 57 and averaged 21. Expressed in general terms, the indices of motion were distributed as shown in Table II.

TABLE II.

	Cases
Normal (Index of 90–100)	0
Good (Index of 60–90)	0
Fair (Index of 30–60)	22
Poor (Index of 1–30)	28
No motion (0)	7

Instability. Twelve patients presented dislocations before operation. Ten of these were the result of suppurative arthritis, 1 was a fracture dislocation and 1 was a congenital dislocation complicated by poliomyelitis.

Deformity. Some degree of deformity was the rule. Flexion deformity was noted before operation in 52 instances and lateral deformity, usually adduction, in 37. Severe flexion deformity (over 35) occurred 14 times and pronounced adduction (over 10 degrees) 15 times.

Shortening. Shortening was noted before operation in 51 patients and the average amount was 0.9 inch. Eighteen of these were suppurative cases and their average shortening was 1.5 inches. The average shortening in the remainder of the patients was 0.4 inch.

In one or two instances, due to an accompanying pathological process in the opposite hip, the shortening was present on the side not operated upon.

THE OPERATIVE PROCEDURES

The operative procedures varied a great deal. This variation in technique was due in part to the fact that the operations were performed by 8 or 10 different surgeons; but in general the type of technique was determined by the conditions found upon exposure of the joint.

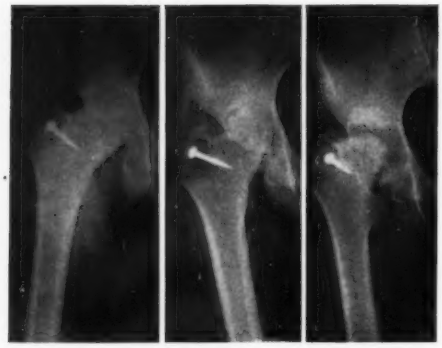
All of the operations were of a plastic nature and can be called arthroplasties, but, in the sense that an arthroplasty attempts to provide a newly constructed joint with as near the normal form and structure as possible and with interposed tissue or artificial membrane, most of the procedures must be termed reconstructions. The two terms, however, are used in this study interchangeably.

When the femoral head was enlarged, overgrown, or deformed, it was the custom either to trim and shape it, thus reducing it in size and sometimes depth, or to remove it completely, thus allowing the rounded end of the neck to engage in the acetabulum. When the femoral head had been destroyed, the end of the neck was reshaped and placed in the acetabulum and the trochanter was usually transplanted to a lower level on the shaft, or was split out laterally to increase the leverage of the abductor muscles and to increase the bearing surface of the superior aspect of the neck. When the femoral neck had been completely or subtotally destroyed, a so called bifurcation operation was used in which the upper end of the femoral shaft was split longitudinally, the medial half reduced into the acetabulum and the outer or trochanteric portion green-stick fractured outward and held in position by bone fragments placed in the cleft.

When the acetabulum was shallow, it was made deeper by curetting or gouging, sometimes to bone. Osteophytic ridges on the margins of the acetabulum were removed.

Usually no interposed tissue was considered necessary but Baer's membrane was used twice,

[1] J. Am. M. Ass., 1931, 97: 1867.



a b c

Fig. 1. C. W. Absorption and sequestration of epiphyseal bone following extensive partial resection of the femoral head in a case of bony ankylosis following gonorrheal infection in a girl, aged 16 years. a, Immediately after operation. After separation from the acetabulum, the head was reduced in size to the diameter of the neck. A double layer of fascia lata was interposed. Motion was begun in 2 weeks. b, Four months after operation. Aseptic sequestration has occurred superiorly in the head and absorption inferiorly. c, Three years after operation. The sequestrum was removed 8 months after the arthroplasty. Preoperative pain, 0; 3 years after operation, 2 plus. Preoperative index of function, 0; 3 years after operation, 26.

a single layer of fascia lata 4 times, a double layer 4, and a pedicle fibrous tissue flap once.

In 1 patient (with compression fracture of the head with resultant osteo-arthritis) the operation consisted only of a removal of loose bodies from the acetabulum and a covering of the head with a single layer of fascia lata. In 1 of the cases of residual suppurative arthritis in which the head and some of the neck had been destroyed, a shelf of bone was turned down from the ilium to overlie the reduced and reshaped upper end of the femoral shaft. In a case of bony ankylosis following suppurative arthritis, the end of the femur was chiseled free and made to articulate beneath a narrow shelf or ridge left on the ilium. In a patient who had a painful fibrous ankylosis following gonorrheal infection, the proximal portion of the femoral head was inadvertently left in the acetabulum. The neck was covered with fascia and reduced. The remnant of head became fused to the acetabulum, but motion was retained between the head and the neck; and this has turned out to be one of the best results.

The femoral head was trimmed, reshaped, reduced in size and sometimes depth in 24 instances; it was completely or subtotally (¾ or more) removed in 25. The acetabulum was curetted, deepened, "excavated" or gouged in 21 patients. In

a b c

Fig. 2. V. V. Aseptic sequestration of the femoral head following extensive partial resection at arthroplasty in a young woman aged 24 years with chronic infectious arthritis of the hips. The head was reduced to one-half its size and the trochanter was transplanted. Motion was started at 5 weeks. Sequestration of epiphyseal bone occurred, but the sequestrum eventually reunited to the neck. a, six months after operation. The line of sequestration is visible. b, Three years after operation. The sequestrum is present and is of increased density. c, Six years after operation. The sequestrum has reunited to the neck. Preoperative pain, 3 plus; 6 years after operation, 1 plus. Preoperative index of function, 5; 6 years after operation, 8.

2 of these the records state that bone was exposed after the gouging or curetting and in 1 a new acetabulum made out of solid bone. The greater trochanter was transplanted or split out 51 times.

Postoperative treatment. Usually plaster immobilization was maintained for from 3 to 6 weeks after operation. This was done chiefly to allow the transplanted trochanter to become firmly united before motion was begun. In 9 patients, for reasons not stated in the histories, plaster casts were kept on for several months. Seven of these were patients with residual suppurative arthritis accompanied by dislocation and in whom the danger of redislocation was probably great.

The average time that motion was begun after operation was 6.5 weeks. In 7, motion was started within 2 weeks. The average pre-operative index of these 7 was 10, and at follow-up, 24. All the gain occurred in 4.

Physiotherapy was continued for as long as possible after the patient had left the ward. Its duration was of course subject to great variation.

COMPLICATIONS

Fortunately there were not many complications. Four deep wound infections occurred. Two of these were in residual suppurative cases. In one of the latter, Staphylococcus aureus was cultured at the time of operation. The original infection in this case had occurred 8 years prior to

a b c d

Fig. 3. M. C. Sequestration and absorption of femoral head following partial resection in an arthroplasty on a girl aged 8 years who for 1 year had had a stiff hip after open reduction for congenital dislocation. The head was reshaped and the upper part of the acetabulum was enlarged. A double layer of fascia lata was interposed. The trochanter was not transplanted. Motion was begun in 2 weeks. a, Immediately after operation. b, One month after operation. The head has separated from the neck. c, Seven months after operation. The head is absorbing and the neck and shaft have subluxated. d, Fifteen months after operation. Further absorption of the head has occurred. The femur has subluxated. Pre-operative pain, 0; 3 years after operation, 0. Pre-operative index of function, 0; 3 years after operation, 32.

arthroplasty and all sinuses had been closed for 5 years. Four patients developed sinuses. Two of these occurred in the 2 residual suppurative cases with wound infections. Other complications were: massive skin flap necrosis, 2 cases; stitch abscess, 1; superficial wound infection, 1; hematoma, 1; non-fatal pulmonary embolus, 1.

SUBSEQUENT OPERATIONS

Eight patients subsequently had hip fusion operations because of failure of the arthroplasty. In 2 patients a transplantation of the trochanter to increase abductor muscle leverage was done; in 1 a re-attachment of a trochanter that had pulled loose; in 1 a shelf stabilization for failure to achieve stability following reconstruction for residual suppurative arthritis with dislocation; and in 1 removal of an aseptic sequestrum from the femoral head. In addition, a few hip stretchings or mobilizations under anesthesia were performed.

RESULTS

Mortality. There were no operative deaths but 2 patients have subsequently died: 1 of carcinoma of the ovaries 5 years after arthroplasty, and 1 of nephritis 6 years after arthroplasty.

Pain. The average amount of pain before operation was 2 plus; at follow-up examination, 1 plus. Twenty-six patients had no pain after operation; 21, 1 plus; 11, 2 plus; 5, 3 plus; and 3, 4 plus. No note was made in 4. Fourteen of the patients before operation had no pain. At follow-up, 10 of these were still free of pain, 2 had 1 plus and 1 had 2 plus pain. No note was made in 1. Fifty-two of the patients before operation had painful hips. At follow-up, 14 of these were free from pain and 36 were still painful (no note in 2). Of the 39 that were painful after arthroplasty, 26 were less painful than before the operation, 5 were more painful and 8 were the same (Table III).

TABLE III.—RESULTS AS TO PAIN

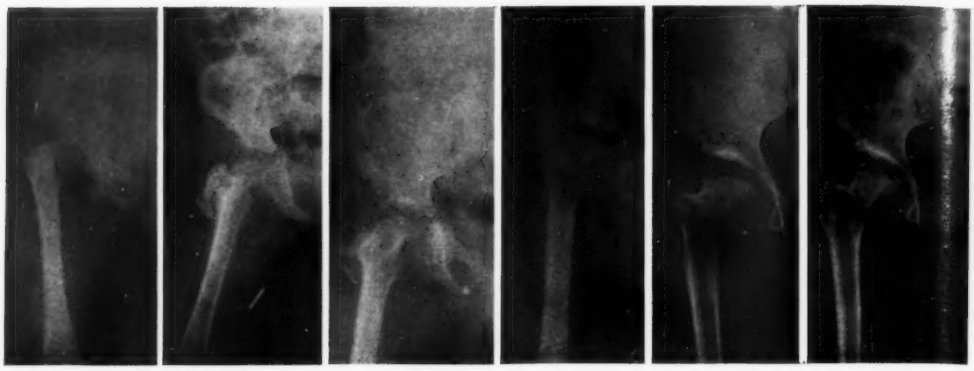
Average pain pre-operatively ..... 2 plus
Average pain at follow-up ..... 1 plus

	Before operation cases	At follow-up cases
No pain	14	26
1 plus	4	21
2 plus	12	11
3 plus	26	5
4 plus	10	3
No note	4	4
	70	70

Hips painless before operation 14
Results: No pain, 10; pain, 3; no note, 1
Hips painful before operation 52
Results: no pain, 14; pain, 36; no note, 2
Hips painful after operation 39
Less painful than before operation, 26; the same, 8; more painful, 5.

Mobility. The average index of function before operation was 21, at follow-up examination 18, all patients with dislocations (13) being excluded.

Expressed in general terms, the follow-up indices after operation were distributed as follows:



a b c d e f

Fig. 4. L. C. Arthroplasty for residual suppurative arthritis with dislocation in child aged 1¼ years. At operation, the acetabulum was deepened exposing bone. The end of the femoral neck was trimmed. The trochanter was braced outward from the neck ¾ inch and supported in position by a bone transplant. Motion was begun in 6 weeks. The series of roentgenograms shows the joint changes that occurred over a period of 5 years. Before operation, the patient was free from pain, but dislocation was present; and the index of function was 90. Six years after operation, she had no pain, the index was 69, and reduction of the dislocation had been maintained. a, The pre-operative condition. b, Two months after operation. c, Six months after operation. d, Fourteen months after operation. Absorption is beginning at the articular surface of the neck. e, Three years after operation. f, Five years after operation. Absorption is more marked.

normal (index 90-100), 0; good (index of 60–90), 2; fair (index of 30–60), 11; poor (1–30), 34; no motion (0), 9; no note, 1.

The index of function was improved in 29 per cent (16 patients) and the average gain was 22; it was lowered in 39 per cent (72 patients) the average loss being 20; it was changed by less than 5 or not affected in 32 per cent (18 patients).

Comparison with the pre-operative condition is made in Table IV.

TABLE IV.—RESULTS AS TO FUNCTION
DISLOCATED CASES EXCLUDED

Average index before operation	21
Average index at follow-up	18

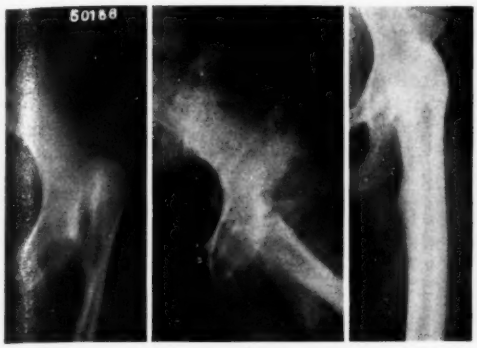
	Before operation	At follow-up
Normal motion (90-100)	0	0
Good motion (60–90)	0	2
Fair motion (30–60)	22	11
Poor motion (1–30)	28	34
No motion (0)	7	9
No note	—	1
	57	57
	Cases	Per cent
Index improved	16	29
Index lowered	22	39
Index unaffected	18	32

Average gain in index, 22.
Average loss in index, 20.

Thirty-five patients had pre-operative indices of from 0 to 30, and 22 of from 30 to 60. The average follow-up index for the former group was 11 and for the latter 30. These figures indicate that in general those patients with fair ranges of mobility before operation retained fair motion after and that those with poor mobility finished with little motion.

Relation of pain to mobility after operation. Absence of motion by bony fusion or tight fibrous ankylosis occurred more often in the hips that at follow-up examination were not painful (31 per cent of 26) than in those that were (3 per cent of 40). This indicates that absence of motion was probably a factor in the number of hips that were eventually free from pain after arthroplasty was performed.

Results as to pain and mobility in relation to etiological groups. The number of patients in most of the groups is so small that no conclusions can be drawn except in the divisions of osteo-arthritis and residual suppurative arthritis. In the former group of patients, alleviation of average pain occurred (average before operation 3 plus; after, 1 plus) but motion in general was somewhat decreased (average pre-operative index, 28; postoperative, 23). In the latter group, average pain was unaffected (average before operation, ½ plus; after, ½ plus) and motion was generally lost (average pre-operative index, 10; patients with dislocations, 40; postoperative, 4; patients with dislocations, 15).



a b c

Fig. 5. R. B. Residual suppurative arthritis with dislocation in a girl aged 17 years. The original infection occurred at the age of 1 year. At operation, fibrous tissue was removed from the acetabulum, the trochanter was removed and transplanted; and the intertrochanteric portion of the femoral shaft was placed in the acetabulum. Motion was started at 7 weeks. The end-result was fusion of the joint. a, Before operation. b, Immediately after operation. c, Five years after operation.

Dislocation. Dislocation was cured in 8 of the 12 patients that presented this complicating abnormality before operation. Four remained uncured. The average pre-operative index was 73 and at follow-up 37. Excluding the 4 patients with residual dislocations the average follow-up index was 27. A good deal of mobility was therefore sacrificed for stability. One patient (an osteo-arthritic) with no dislocation before operation suffered a dislocation several years after.

Deformity. Flexion deformity after operation was recorded in 37 instances and lateral deformity in 38. Severe flexion deformity (over 35°) occurred 7 times (14 times before operation) and pronounced adduction deformity (over 10°) 3 times (15 times before operation). Three patients with less than 35 degrees of flexion deformity before, had more than 35 degrees after operation; and 2 patients with slight adduction deformity before had excessive adduction after.

Shortening. Shortening was noted at follow-up examination in 26 patients and the average amount was 1.5 inches (0.9 inch before operation).

Results in those with bony ankylosis. Of the 4 patients who had bony ankylosis before operation, 3 from suppurative arthritis and 1 from gonorrhea, 3 presented bony ankylosis at follow-up and 1 (the neisserian infection) mobility with an index of 26. The last, however, had pain.

Effect of interposed tissue. As already stated some form of interposed tissue, usually fascia

a b c

Fig. 6. H. B. Arthroplasty for residual gonorrheal arthritis in a male aged 29 years. It was intended at operation to remove the entire femoral head but the proximal portion was inadvertently left in the acetabulum and the pointed end of the neck was placed against it, but separated from it by a double layer of fascia. Motion was begun in 4 weeks. The remnant of head eventually became fused to the acetabulum, but a good range of motion without pain was preserved between the fused portion of head and the neck. a, The pre-operative condition. b, One month after operation. c, Two and one-half years after operation. Pre-operative pain, 1 plus; 3 years after operation, 0. Pre-operative index of function, 4; 3 years after operation, 56.

a b

Fig. 7. E. F. Arthroplasty in a woman aged 40 years for osteo-arthritis following an old coxa plana. The head was removed and the remodeled end of the neck was placed in the acetabulum. The trochanter was not transplanted and interposed tissue was not used. Motion was begun within a few days, but had to be discontinued because of the occurrence of several non-fatal pulmonary emboli. At 8½ weeks, the patient was walking with crutches. a, Before operation. Note the tremendous amount of structural deformity present. b, Three years after operation. Pre-operative pain, 4 plus; 3 years after operation, 1 plus. Pre-operative index of function, 32; 3 years after operation, 31.

lata, was employed in 11 patients whose average pre-operative index was 10. Five gained in index by 26, 32, 28, 52, and 5, respectively, 2 lost by 14 and 36; and 4 were unaffected or changed by less than 5. The average postoperative index was 18.

Effect of the amount of bone removed from the femoral head. It has been observed by Albert Ferguson that it is not safe to remove more than one-third of the circumference of the femoral head because absorption of the remaining portion will often occur, which may materially and probably adversely affect the end-result (Figs. 1, 2, and 3). Therefore, if circumstances demand that more than that amount be resected, it is wiser to remove the head completely and to reshape the end of the neck for articulation with the acetabulum.

THE DEVELOPMENT OF A BETTER OPERATIVE TECHNIQUE

From a study of these cases, certain principles of arthroplasty have been derived:

1. More than one-third of the circumference of the femoral head must not be removed; if conditions demand the resection of more bone, the femoral head should be removed completely.

2. The remodeled head or neck should preferably be covered with a double layer of fascia lata.

3. The trochanter should not be transplanted at the time of the reconstructive procedure. It is left intact so that motion can be begun immediately. (This does not apply to patients who have practically no femoral neck in which the trochanter, at the time of operation, must be removed or propped out in order to provide a femoral bearing surface to articulate with the acetabulum.)

4. Motion must be started immediately or within 2 or 3 days of operation and physiotherapy must be continued for many months after.

5. A proper selection of cases must be made, if good results are to be anticipated. Lazy or indifferent individuals or those with a low threshhold value for pain are not good subjects for arthroplasty. Patients who have had ankyloses for years and, consequently, have markedly atrophied muscles which cannot possibly function after mobilization of the joints, or those who present gross damage or tremendous deformity of structure, usually will not obtain good results.

Since October, 1934, 10 patients have been operated upon with these principles in mind. All have been examined a year or more after operation and the results have been most encouraging. The trochanter has been transplanted at a second operation in 1 patient because there was insufficient length of neck for a stable joint. One patient has sustained a dislocation following a severe and deep operative infection. The patients have good ranges of motion, with a substantial gain in the index in every instance, and in general have decreased pain.

It must be borne in mind, however, that pronounced pain and limp may persist after a mobilizing operation. Before an arthroplasty is performed, therefore, the patient should thoroughly understand this fact and be willing to accept this possibility in order to obtain or preserve mobility. A fused hip, however, in optimum position and in unilateral cases gives a beautiful end-result, providing a painless, stable extremity, without marked limp, that can be relied upon for full use. Consequently, in many instances, hip fusion may be the operation of choice.

SUMMARY

1. A study of all the arthroplasties and reconstruction operations on the hip joint that have been performed at the New York Orthopedic Dispensary and Hospital from August, 1916 to October, 1934 has been made.

2. The terms "arthroplasty" and "reconstruction" are used interchangeably in this study to denote a mobilizing procedure.

3. Seventy-five operations have been done on 71 patients. Five cases, for reasons outside of our control, were followed for less than 1 year. This leaves 66 patients with 70 operations that have had a follow-up examination of more than 1 year. The longest follow-up time is 12 years and the average is 3.5 or 4 case-years.

4. The average amount of pre-operative pain was 2 plus (scale 0–4 plus), and the average amount at follow-up was 1 plus.

5. The average functional index before operation was 21 and at follow-up examination 18. The index was improved in 29 per cent with an average gain of 22; it was lowered in 39 per cent with an average loss of 20; and it was unaffected in 32 per cent.

6. Twelve patients presented pre-operative dislocation. This was cured in 8, but at the sacrifice of a good deal of mobility. One patient who did not have a dislocation before operation had one 2 or 3 years later.

7. Certain principles of arthroplasty that have been derived from the study of these cases are stated. These have changed the technique of operation since 1934.

8. With these principles in mind, much better results have been obtained in 10 patients that have been so operated upon and followed for more than 1 year.

THE USE OF LIVING SUTURES OF THE EXTERNAL OBLIQUE APONEUROSIS IN THE REPAIR OF INGUINAL HERNIAS IN ADULTS

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IT IS the purpose of this article to report an operative technique for the repair of inguinal hernias and to propose the routine use of fascial sutures in the repair of inguinal hernias in adults.

Several autoplastic operations have been reported. The original one was devised by McArthur and reported by him in 1901. He employed the Bassini principle of repair but used pedicled strips of the external oblique aponeurosis as sutures to approximate the conjoined and Poupart's ligaments and to reapproximate the cut edges of the external oblique aponeurosis. The technique here described differs from the McArthur operation in that it incorporates a detail which I believe contributes much security, particularly in the repair of that group of hernias which have inadequate but not totally deficient support in the superpubic portion of the inguinal triangle. These include direct and combined direct and indirect, or saddle bag, hernias in which the aponeurosis of the internal oblique inserts into the pubis or sufficiently low that it can be approximated to Poupart's ligament without much tension and also the indirect hernias which have lost their obliquity because the internal rings extend down to the pubis.

This detail consists of utilization of the triangular fascia, the ligamentum inguinale reflexum —Colles's ligament—to obturate completely the small triangular defect which is left between the pubic spine and the lowermost approximating stitch in the classical operations.

Although utilization of this band of fascia in repair has been referred to in the literature, it is my impression that its existence, or at least its importance, is not adequately appreciated. This ligament is reflected from the external oblique fascia over the anterior superior aspect of the pubic spine in intimate contact with the periosteum and is continuous with Poupart's ligament laterally. Its free border superiorly forms a hood which can be lifted sufficiently to receive one suture to approximate it to the internal oblique or conjoined tendon. This firmly closes the vulnerable area immediately above the pubic spine. Failure to obliterate this defect is responsible for many recurrences, inasmuch as the hernial sac or a diverticulum from a direct hernial bulge is protruded through the defect and provides an effective dilating wedge which enlarges the defect and breaks down an otherwise efficient support.

TECHNIQUE

The usual oblique hernial incision is made over the inguinal canal and is extended inferiorly sufficiently to expose the anterior surface of the pubic spine and superiorly to expose the musculo-aponeurotic juncture of the external oblique muscle. Beginning with the external ring the external oblique aponeurosis is incised over the canal. The edges of the fascia are held apart by retractors to preserve this tissue undamaged for use subsequently as sutures. As the cord is lifted from the canal, the cremasteric fibers and transversalis fascia are dissected from it. The sac in all indirect hernias and the diverticulum in direct hernias (when present) are opened, dissected free down to the neck, and excised. The neck of the sac is ligated as high as possible. This, I believe, is a very important step because failure to do so leaves a cone which acts as a dilating wedge responsible for some recurrences. The transversalis fascia, the lateral border of the internal oblique muscle, and its aponeurosis, and the shelving fold of the external oblique fascia are widely exposed and wiped free of fat. It now becomes necessary thoroughly to expose the superior and anterior surfaces of the pubic spine and the transversalis fascia, and to clean both surfaces of the exposed portion of the external oblique fascia of fat.

As illustrated in Figure 1, a strip approximately 1.5 centimeters wide is cut from the superior mesial flap of the aponeurosis of the external oblique, severing it at the musculo-aponeurotic juncture above but leaving it attached below. It is important to free it down to the inferior border of the pubic spine. Usually it is possible to obtain a strip of 18 centimeters or longer. The free end is fastened to a fascial needle. I use an atraumatic needle of my own design, described elsewhere

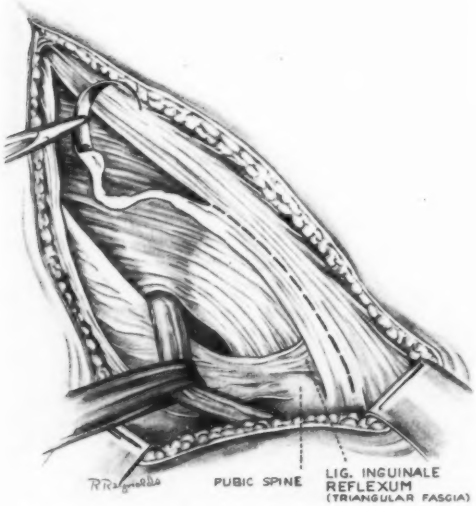

Fig. 1. Illustrated are certain essential technical details. The anterior and inferior surfaces of the pubic spine are exposed in order to develop the triangular fascia and to permit freeing of the strip of external oblique aponeurosis to a level below the triangular fascia. The line of incision is indicated by the broken line. The free end of the suture has been fastened to the author's needle, which is described in an article now in press (2). The stump of the hernial sac and the tissues in the floor of the canal were blacked out in the drawing to emphasize the borders of the inguinal triangle.

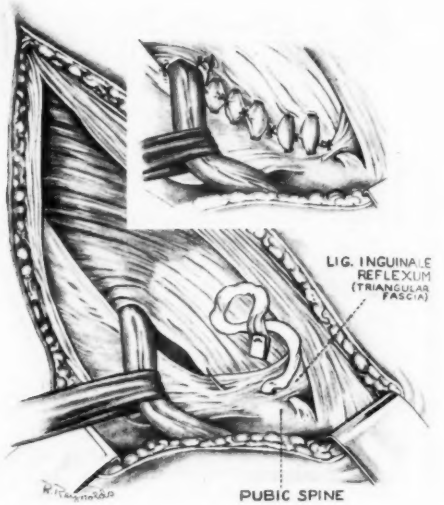

Fig. 2. The fascial suture first seals the superpubic area by passing over the pubic spine and then through the triangular fascia and unites it to the internal oblique aponeurosis. The suture is then continued upward approximating the internal oblique and the transversalis fascia to Poupart's ligament. Each stitch includes the transversalis fascia. As shown in the insert, interrupted silk sutures are placed in the gaps between the fascial loops and are used to unite the adjacent edges of the loops. Completed, this forms a continuous band of fascia from the pubic spine to the internal ring.

and shown in Figures 1 and 2. Since this needle does not require doubling of the fascia in threading, it obviates the difficulty and the tearing and trauma from dragging a bulky mass of fascia through tissues. The end of the fascial strip is inserted between the flanges in the head of the needle where it is secured with a suture of fine silk passed through drill holes. The needle threaded with fascia is first passed through the triangular ligament from below and anteriorly, and then into the internal oblique (conjoined) tendon lying immediately posterior and mesial to the triangular ligament. It is next passed through Poupart's ligament at its juncture with the triangular ligament and then continued as a continuous suture approximating Poupart's ligament to the transversalis fascia and to the internal oblique muscle and its tendon.

By inclusion of the transversalis fascia in each stitch the floor of the inguinal triangle is narrowed and strengthened and the internal ring with the cord is displaced upward more effectively. The end of the fascial strip is then anchored to the surface of the internal oblique fascia with two encircling and transfixed sutures of silk. Between the fascial loops are placed interrupted sutures of silk to relieve tension and to insure intimate approximation of the layers. The fascial loops are then unfolded and the adjacent edges brought together with interrupted silk sutures to close the gaps and form a solid band of fascia. Silk is used in preference to catgut because it incites less tissue reaction and probably gives stitch service for a longer period of time.

With one or two sutures of silk or chronic catgut, Poupart's ligament and the internal oblique muscle are approximated above the cord. These sutures are so placed that the new formed ring fits snugly around the cord.

The edges of the external oblique fascia are then approximated under the cord with interrupted silk sutures. This is usually possible despite the loss of the strip used for a suture. If, however, this cannot be done without tension a second narrower strip is cut from one of the flaps and used as a pedicled suture to lace the edges of

the flaps, or the superior one is brought down as far as possible and sutured to the internal oblique fascia. Above the cord the edges can always be approximated. The superficial fascia is reunited over the cord and the skin is closed with interrupted sutures.

This technique is applicable in all but a few cases. Occasionally, the aponeurosis of the external oblique is inadequate or unsuitable for use as sutures. This difficulty may be encountered in recurrent hernias. Under such circumstances strips of fascia lata can be substituted. Again, there are those direct hernias in which the internal oblique aponeurosis is either wanting or inserts into the rectus sheath at some distance above the pubic spine. In these cases the inguinal triangle is very broad and there is need of more fascia for support than can be supplied by strips of the external oblique aponeurosis. Since hernias of this type are often asymptomatic, are unlikely to strangulate, usually occur in older, less active individuals, and recur in such a high percentage of instances following operative repair, Andrews has questioned the advisability of treating them surgically. Certainly, if repair is undertaken, such autoplastic operations as those of Gallie, Halsted, Bloodgood, Andrews, and Wangensteen are indicated. Recently, I have used an operation which will be described in a subsequent publication.

In children, recurrences after the classical operations are rare and autoplastic operations of any type are unnecessary. This has been emphasized by Hoguet in his statement that in 827 consecutive and personally executed operations for inguinal hernias in children not a single recurrence had developed up to the time of his report.

The use of strips of the external oblique aponeurosis for fascial sutures has certain advantages. The entire operation can be carried out within a single wound not significantly larger than that necessary for any other type of repair. Consequently, the chances of a break in asepsis with infection is minimized. At the distal end the normal attachment of the fascial strip is preserved; thereby a secure anchorage and some blood supply is maintained. For this reason there is less chance of the suture slipping and some questionable vascular aid to survival of the fascia. Finally, the fashioning and placing of the suture requires very little time and inflicts little or no additional trauma to the patient.

The operation strongly fortifies the entire inguinal triangle. This is an important detail in all hernias including even the simple indirect types which, when they recur, recur not infrequently in the form of direct hernias. Thus, indirect hernias should be considered potential direct hernias and the repair planned accordingly.

THE RATIONALE OF THE ROUTINE USE OF LIVING SUTURES OF FASCIA

In published and unpublished reports dealing with the operative repair of hernias two facts stand out: (1) most analyses of large series of cases, which have had adequate tests of time, reveal recurrences in excess of 10 per cent in direct hernias and 7 per cent in indirect hernias; and (2) from impressions and from such follow-up observations as are available there has evolved the opinion among several surgeons that living sutures of fascia contribute much to the security of repair and should be used for recurrent and other hernias uncertain or impossible to retain by other means. If fascial sutures give added security and are indicated for repair of these more difficult types of hernias, it logically follows that the more routinely used for the repair of simpler hernias the fewer will be the recurrences. Concurring in this opinion, as expressed by Gallie, I have used routinely the autoplastic operation here described for all inguinal hernias in adults with the exception of the grossly deficient type of direct hernia discussed previously. Inasmuch as the use of sutures of external oblique fascia does not appreciably increase the duration or trauma of operation or the likelihood of infection, there appears to be no particular contraindication to their use routinely. But why should an operation of this type be used routinely for simple indirect hernias?

Unquestionably, many indirect hernias are cured when the sac is disposed of and the usual subsequent repair is superfluous. Again, most of them and some of the direct hernias are retained adequately by the support of the Ferguson or Bassini types of repair. However, the mere fact that statistics show that recurrences do develop in an astonishingly large number of indirect as well as direct hernias and occur in the hands of the most competent surgeons and in the presence of circumstances which are considered favorable to cure, indicates the need of technical improvement in the operations themselves or their applications. As stated previously, indirect hernias recur not infrequently as direct hernias so that an adequate repair should preclude this possibility as well as cure the primary indirect hernias.

Some recurrence records from representative American and European clinics are presented in Table I with the names of the surgeons who made the report.

TABLE I.

Author	Date	Number of cases		Percentage recurrence			
		Indirect	Direct	Indirect silk or catgut sutures	Fascia sutures	Direct silk or catgut sutures	Fascia sutures
Fallis	1937	646	154	7.4	0	11.6	0
Andrews and Bissell	1933		48			27	0
Burrows	1931		28			23	
Blake						25	
Erdman	1923	665	313	3.0		16.61	
Hoguet	1923	963	249	1.6		6.8	
Lameris	1912	511	102	3.9		28.4	
Druener	1919	502	171	5.0		18	
Neidlich	1921		222			23	
Taylor	1920	2,230	256	5.63		18.08	
Lyle	1928	301	125	9.0	3	14	9.5
Cattell and Anderson	1931	123	51		4.6		7.8
Burdick, Gillespie and Higinbotham	1937	202	310		17.3		25.8

Many hernias listed above as direct hernias were combined direct and indirect hernias.

These statistics present a low percentage of recurrence when fascial sutures were used. However, included in the table are too few reports of the results from the use of fascial sutures to give a proper comparative evaluation of the method. However, with the exception of the Burdick, Gillespie, and Higinbotham series, the recurrence rates in general are definitely lower than are those resulting from other methods of repair. This difference is well shown by the direct comparison in Lyle's series and it becomes more significant in lieu of the statement made by all three authors including Burdick and associates that the cases in which fascial sutures were used were principally the more difficult ones.

Fascia has certain qualities which make it a superior suture material. These have been pointed out by Gallie. He has shown that fascia incites no inflammatory reaction, survives for years if not indefinitely, unites with the tissues in which it is imbedded, has great tensile strength and does not stretch under pressure as does scar tissue. This is an important difference because the support from the classical type of repair is as strong as the scar which unites the aponeuroses so that the tendency of scar tissue to stretch and give way under pressure is probably a responsible factor in recurrences. It has been my experience, however, to find Poupart's and the conjoined tendons widely separated and presenting surprisingly little scar or evidence of a previous fusion.

SUMMARY

1. An autoplastic technique for the repair of inguinal hernias is reported. This technique is original only in so far as it combines certain established principles. It has the advantage of the security obtained from the use of living sutures of fascia without increasing perceptibly the duration and trauma of operation. It utilizes the triangular ligament to solidify the repair by closing the vulnerable area immediately above the pubic spine.

2. The logic for adopting the routine use of autoplastic repair of inguinal hernias in adults is stated.

BIBLIOGRAPHY

1. Andrews, E., and Bissell, A. D. Direct hernias: a record of failures. Surg., Gynec. & Obst., 1934, 58: 753.
2. Bisgard, J. D. An atraumatic needle. Am. J. Surg. In press.
3. Blake. Quoted by Andrews and Bissell.
4. Bloodgood, J. C. The transplantation of the rectus muscle or its sheath for the cure of inguinal hernia when the conjoined tendon is obliterated. Ann. Surg., 1919, 70: 81.
5. Burdick, C. G., Gillespie, D. H. M., and Higinbotham, N. L. Fascial suture operations for hernia. Ann. Surg., 1937, 106: 333.
6. Burrows, H. J. A note on direct inguinal hernia. St. Bartholomew's Hosp. Rep., 1931, 64: 195.
7. Cattell, R. B., and Anderson, C. End-results in the operative treatment of inguinal hernia. New England J. Med., 1931, 205: 430.
8. Druener, O. Die Operation der Leistenhernie. Deutsche Ztschr. f. Chir., 1919, 150: 7.

9. ERDMAN, S. Inguinal hernia in the male. Ann. Surg., 1923, 77: 171.
10. FALLIS, L. S. Inguinal hernia. A report of 1600 operations. Ann. Surg., 1936, 104: 403.
11. GALLIE, W. E., and LEMESURIER, A. B. The use of living sutures in operative surgery. Canadian M. Ass. J., 1921, 11: 504.
12. Idem. The transplantation of fibrous tissue in the repair of anatomical defects. Brit. J. Surg., 1924, 12: 289.
13. HALSTED, W. S. The cure of the more difficult as well as the simpler inguinal ruptures. Johns Hopkins Hosp. Bull., 1903, 14: 208.
14. HOGUET, J. P. Observations on 2468 hernia operations by 1 operator. Surg., Gynec. & Obst., 1923, 37: 71.
15. LAMERIS, H. J. Zur Behandlung der indirekten Leistenhernie. Deutsche Ztschr. f. Chir., 1912, 119: 569.
16. LYLE, H. H. M. Fascial sutures for inguinal hernia. Ann. Surg., 1928, 88: 870.
17. MCARTHUR, L. I. Autoplastic suture in hernia, and diastases. J. Am. M. Ass., 1901, 37: 1162.
18. NEIDLICH, V. Erfahrungen und Resultate bei Operierten Leistenhernien. Deutsche Ztschr. f. Chir., 1921, 165: 34.
19. TAYLOR, A. S. The results of operations for inguinal hernia. Arch. Surg., 1920, 1: 382.
20. WANGENSTEEN, O. H. Repair of recurrent and difficult hernias and other large defects of the abdominal wall employing iliotibial tract of fascia lata as pedicled flap. Surg., Gynec. & Obst., 1934, 59: 766.

MODIFIED WANGENSTEEN SUCTION DRAINAGE

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THE Wangensteen method of suction drainage has proved itself of great value in intestinal obstruction of the non-strangulated type. The method, here described, is I believe a simplification of the original, being the same in all particulars except the production of suction.

Suction can be obtained by either a water aspirator or by an electrically driven pump. My experience has been with the motor driven pump designed by Dr. Stedman for suprapubic bladder drainage. The motor (eddy current) operates on 110 volts and 60 cycles. It is small, almost noiseless, can be run indefinitely with no other attention than being oiled every 2 days, does not over-heat, and is not harmed by being stalled. It is efficient up to 15 inches mercury negative pressure. In connection with the pump, the makers have designed for me a valve to regulate the vacuum. A manometer, of the water or mercury type, is used to determine the vacuum.

The details of the valve are shown in the upper middle part of the illustration. At the mid-portion of a tube is an annular, perforated flange, x', on which seats a movable disc valve, x. Attached to either side of this valve are springs, the stronger, m, being on the pump side, and the weaker, m' on the intake side. At o there is a perforated plug threaded into the tube. Screwing this plug inward compresses the spring m', thus lessening the forces exerted by the stronger spring, m. Decreasing the tension upon it has the reverse effect. It can be so adjusted that the disc will be unseated by negative pressure greater than zero, and less than 10 inches (mercury).

For the low pressures used in the Wangensteen method, the ordinary gauge is not sufficiently delicate, or accurate, and therefore, a water manometer was constructed along the lines devised by Dr. Donald Gordon. It consists of a tube, 1 inch in diameter, with a small opening just above the lower end, and a T outlet at the top, one branch of which is connected to the source of suction and the other to the shorter tube of a two tube stoppered collecting bottle. The lower end of the manometer is placed in a glass of water and the position of the small opening so adjusted that the desired vacuum can be obtained. When suction is applied and the stomach end of the tube is obstructed, a vacuum is produced in the bottle and in the manometer, thus drawing the column of fluid up into the tube. When the water level in the glass reaches that of the small opening, air is drawn into the tube and thus the production of a vacuum greater than that measured by the height of the water column is prevented. With the small opening near the bottom and the large caliber of the tube, the air enters in bubbles and does not blow the water out of the tube, as would happen with a small caliber tube. Without a regulatory apparatus on the pump, this action is too turbulent.

The valve, which is on the electric motor, or on the frame work of the water instrument, is so adjusted that it allows air leakage into the system in just the amount to obtain the desired vacuum.

In practice, it is well to adjust the instrument so that, when the desired vacuum is obtained, the water level in the tumbler is just above the small opening in the tube. Should, by chance, anything happen to the valve that would impair its action and the vacuum be raised, air would be sucked through the small hole and the manometer act as a safety protection.

A U shaped mercury manometer can be substituted for the water instrument by connecting it with a T tube, one arm to the pump (either water or motor) and the other to the collecting bottle. The only advantage it has over the water instrument is its compactness; a disadvantage is that it is not so accurately adjustable, as 1 inch of mercury is the equivalent of 13.6 inches of water.

Gastric and duodenal suction drainage is best carried on at a negative pressure of 24 to 30 inches of water at the intestinal end of the tube. The pump vacuum should be so adjusted that it, combined with the negative pressure produced by the column of fluid between the stomach and bottle, equals the desired operating value. For example, if one is to work with a suction of 24 inches and the bottle end of the tube is 12 inches lower than the intestinal end, the apparatus should be so adjusted that the manometer will read 12 inches.

When the water aspirator is used, the faucet is so adjusted that the desired vacuum is obtained with the least water flow. The valve at f and the manometer will keep the instrument at the proper level.

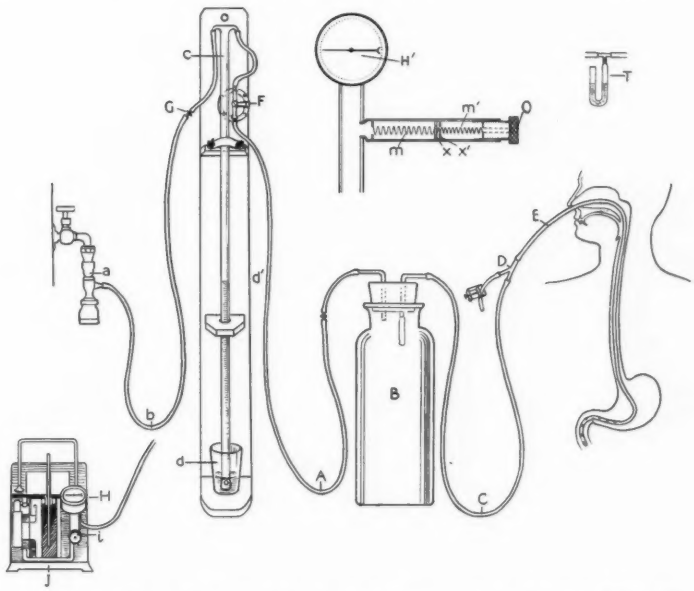

Fig. 1. Two sources of power, two methods of measuring the negative pressure, and one of regulating the vacuum are portrayed. These can be hooked up in several combinations. Water pump, *a*, is connected to water manometer, and this to bottle. The suction is regulated by valve, *F*, detail of which is seen in upper middle part of illustration. Electric pump can be substituted for water pump with the control valve an integral part of it. Instead of the water manometer, the mercury one, *T*, can be connected between the pump (either water or electric) and connecting bottle.[1]

The method is simple, needs only a minimum of attention, takes up very little space, and is highly efficient. As an illustration of the dependability of the electric pump on a suprapubic bladder drainage case, it was run for 9 weeks, practically continuously, with no other attention than oiling the motor every other day. The run was terminated when the patient left the hospital, and there was no indication that it could not have been continued for an indefinite period. In intestinal suction drainage cases it has been run for 3 to 5 days and stopped only because there was no further need for it.

[1]Since this illustration was made the American Cystoscope Makers have produced a pump in which the regulating valve and an adjustable mercury manometer are incorporated as integral parts.

EDITORIALS

SURGERY
Gynecology and Obstetrics

FRANKLIN H. MARTIN
Founder and Managing Editor
1905–1935

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JANUARY, 1939

EDITOR APPOINTED

THE Board of Directors of the Surgical Publishing Company of Chicago have pleasure in announcing the appointment of Dr. Loyal Davis as editor of SURGERY, GYNECOLOGY AND OBSTETRICS, to fill the post made vacant by the untimely death of Dr. Allen B. Kanavel. Dr. Davis, who is professor of surgery and chairman of that department at Northwestern University Medical School, was appointed assistant editor of this journal in 1927 and associate editor in 1933. Under his able supervision the directors expect that the journal's high standard of excellence achieved in past years will be maintained.

ACUTE INFLAMMATION OF THE GALL BLADDER: A PLEA FOR CONSERVATIVE OPERATION

DOUBTS that have lately arisen as to whether "immediate," "early," or "delayed" operations give the best results in the treatment of acute inflammatory conditions of the gall bladder seem to have created a controversy not unlike the discussion that arose years ago concerning the superiority of cholecystectomy over cholecystostomy. Some misunderstanding has arisen as a result of the manner in which the designation of the time of operation has been made. "Emergency" should signify an immediate operation performed within an hour or two after the admission of the patient. The terms "early" and "delayed" are rather indefinite; they may mean any time after the patient has been admitted to the hospital. The term "opportune time," however, seems to me to be the best designation for the proper time to operate on acute cholecystitis or acute empyema of the gall bladder. The opportune time may mean that the operation may be performed immediately upon the admission of the patient or any time thereafter, as the exigency of the case may present itself to the surgeon.

The proponents of the emergency operation fear perforation. Perforation of the gall bladder as a matter of fact is a rare occurrence. In a period extending over 25 years I have had the experience of operating upon one acute perforation of the gall bladder. Pathological anastomoses of the gall bladder with other viscera must be considered perforations but these are not to be confused with the acute types. Perforations of the gall bladder can be prevented if the physician who sees the patient in the first attack of colic would promptly seek the advice of a surgeon. During an attack of acute empyema the patient should be hospitalized immediately and placed under the care of the surgeon. Perforations accompanying acute empyema of the gall bladder

can also be prevented by proper pre-operative care, namely absolute abstinence from water or food by mouth. Parenteral administration of fluids must be insisted upon. In practically every case, even if gangrene is present, the acute symptoms will abate in 24 or 48 hours under this regimen.

A much better and more logical operation in reference to anatomical lines can be performed if the symptoms are allowed to subside. An incomplete operation or one performed in two stages should be avoided because those who have had the stage operations have a more serious convalescence than those who have been operated upon in one stage after subsidence of symptoms.

The morbidity and mortality will be greatly increased if the dictum shall prevail that all acute inflammations of the gall bladder should be operated upon at once. More accidents pursuant to the operation will result when they are performed in the acute stage and the mortality will be correspondingly higher.

MOSES BEHREND.

THE USE OF DRUGS IN SURGERY

IN early periods of development of surgical therapy standardized procedures often were advocated for given diseases, without consideration of individual variations. Thus many surgeons performed gastro-enterostomies on all peptic ulcers. Routines were followed in the management of toxic goiters without regard for the degree of toxicity or the individual responses of the patients. Experience and a better knowledge of the fundamentals of diseases and their treatment have taught that best results can be obtained only when each patient is studied individually and treated by the method best suited to his problem. Certain routines, however, are still followed without taking into account the variations in response, and often without an adequate knowledge of their physiological and pathological effects. This is particularly true of the use of drugs in surgery. Many surgeons have standard pre-operative and postoperative orders for all operations, regardless of the nature of the procedure or individual characteristics of the patient.

Disturbances of intestinal motility such as postoperative nausea, vomiting, distention, gas pains, and ileus constitute a high incidence of surgical morbidity. Patients frequently manifest a greater fear of these complications than of the operation. To combat them a variety of drugs is advocated both for prophylactic and therapeutic use. Claims of high efficiency are made for a number of agents if administered repeatedly before and after operation. Such preparations are often used without a thorough understanding of their action. The difficulty of securing human preparations suitable for accurate study is largely responsible for this confusion.

Many surgeons still hold the opinion that morphine "splints the bowel" although physiologists for years have shown that this drug increases small bowel peristalsis. Recent studies have confirmed this action of the opiates, but have shown that they inhibit motility of the right colon, thus explaining their constipating action.

Other drugs, such as eserine, prostigmin, mecholyl and acetylcholine, also have been shown to increase small bowel motility and inhibit colon contractions. Derivatives of the pituitary gland, pituitrin and pitressin have the opposite effect, diminishing small bowel motility but vigorously contracting the colon. Atropine has an inhibiting effect on the entire bowel and when used with morphine will counteract the stimulating action of the latter drug on the small intestine.

This understanding of the action of drugs enables us to use them more intelligently on our surgical patients. Morphine or other opiates are used to allay pain almost universally before and during the first 24 to 48 hours after surgery. As they increase small bowel peristalsis but inhibit colon contractions, the patient will have bowel contents accumulating in the right colon, where it will remain and liberate gas with resultant distention and gas pains. It seems logical, therefore, that these symptoms can be avoided or relieved by evacuating the colon with enemas, augmented if necessary by a pituitary extract. Gas rarely accumulates and distends the small bowel except in cases in which intestinal obstruction or ileus exists. Most gas pains are due to pressure within the colon. Nausea and vomiting following large doses of opiates may be due to a marked small bowel stimulation with reverse peristalsis resulting. When such symptoms occur these drugs should be discontinued or combined with such agents as atropine or hyoscine to counteract intestinal stimulation. Following surgery on the stomach and small bowel, if we suspect atony from trauma and manipulation, we may encourage peristalsis by the use of opiates, prostigmine, or other stimulating drugs.

These likewise might be of value in ileus. We must, however, remember their inhibiting action on the colon. Most postoperative abdominal distention is due to gas in the colon. Here pituitrin or pitressin combined with enemas serve very well to relieve the distress by emptying the large bowel. It is inadvisable to use them repeatedly every few hours except when specially indicated, because of the paralytic effect on the small bowel.

With an understanding of the action of the various drugs employed we can use them more judiciously, and should be able to offer our patients a more comfortable convalescence.

CHARLES B. PUESTOW.

SIR DAVID WILKIE

1882-1938

UNIV. OF MICH.

MEMOIRS

SIR DAVID WILKIE

THE recent sad death of Sir David Wilkie at the height of his fame and career has been a great loss not only to British surgery but to the whole civilized world for, since medicine differs from most other professions in being international in its scope, he belonged not to Great Britain alone. Wherever there is modern surgery, there will he be mourned.

Born in Kirriemuir, Angus, in 1882, Sir David was educated at the Edinburgh Academy and the Edinburgh University. In 1904 he graduated M.B., Ch.B., and took his higher university degrees of M.D., in 1908 and Ch.M., in 1909. He took the fellowship of the Royal College of Surgeons of Edinburgh in 1907 and that of the Royal College of Surgeons of England in 1918.

After graduation he filled resident posts in Edinburgh, and then studied abroad in Bonn, Berne, and Vienna. In 1914 he was appointed surgeon to the Leith General Hospital, and assistant surgeon to the Royal Infirmary, Edinburgh. During the War he served as surgeon-commander to the Royal Naval Volunteer Reserve. In 1924 he was appointed to the University chair of surgery.

In this period his publications, which were mainly devoted to abdominal surgery, and his powers as a teacher and lecturer were firmly establishing his reputation, not only in his native town of Edinburgh, but throughout the surgical world. In 1929 he was selected by the American College of Surgeons to give the Murphy Oration in Surgery, having been awarded the much prized honorary fellowship of that College in 1926. In the same year he was appointed corresponding member of the French Academy of Surgery and given the fellowship of the Royal Society of Edinburgh. In 1936 he was rewarded with a knighthood and in the same year was made president of the Association of Surgeons of Great Britain and Ireland.

So bare a statement of his record and progress gives, however, no real description of the man. All who knew him admired and respected him. It is, alas, only too often that those who have attained success and fame in their profession are subjected to scathing and spiteful criticism but, although some must have envied him his many gifts, I have never heard, in the many years I have known Wilkie, any unfair censure of his work, or any word other than praise of his character and ability.

His skill and popularity as a teacher are naturally best known to his own students in Edinburgh, but it is characteristic of him that he had the wider outlook, and since his appointment as professor of surgery continued untiringly

to create a department of surgical research, a department which grew in size and reputation until it was known throughout the world and until no surgeon visiting Britain felt that his trip was complete until he had visited Sir David Wilkie. He made Edinburgh a surgical mecca to surgeons in America, England, and the British colonies, while many from other countries have benefited from his skill as a teacher, and what is of much greater value, from his personal magnetism, encouragement, and guidance.

In his surgical work his most striking characteristic was the clearness and lucidity of his thought. I have attended very many surgical meetings with Wilkie and have heard him speak. He usually made his remarks late in the meeting, and one was always struck with his ability to pick out the really salient points, to direct attention to the matters of doubt, and to sum up the situation in a few masterly words. Whatever he said, and upon whatever subject he addressed the meeting one felt that when he had finished the last word had been said, and always his remarks were followed by a round of applause which came spontaneously from surgeons from all parts of the world. It was real and well earned admiration and not the loyalty of local admirers. Whenever he spoke it was manifest that we had the privilege of listening to a real leader of the profession. So greatly was his surgical ability recognized that more and more demands were made upon his time, but his services were always willingly and ungrudgingly given.

He served on the Army Medical Advisory Board; on the Scientific Advisory Committee of the British Empire Cancer Campaign; on the Scottish Board of Health; and on the Medical Research Council. He was also chairman of the Committee of the Ministry of Mines.

Apart from his powers of teaching and of debate he gained fame as a surgeon by his many contributions to surgical literature, each one of which was a masterpiece of lucidity and contained some new point in the advancement of his craft. The value of his original work was recognized in 1918 when he was awarded the Liston Victoria Jubilee Prize of the Royal College of Surgeons of Edinburgh.

These outstanding abilities of surgery, however, illustrate only one side of his character. His wide activities in the social structure of his native town, in which he was so ably encouraged and assisted by Lady Wilkie, made him beloved by all in Edinburgh. For many years he was chairman of the University Settlement which supervised housing schemes and courses of instruction in general educational subjects and in vocational training. In 1933 he purchased an old cinema, reconstructed it, and presented it anonymously to the Settlement as an educational and vocational institute for working class people. There must be many in Edinburgh who feel that they owe him what progress they have made in life. His addresses on many general subjects were much appreciated by large audiences.

It was always a matter of astonishment to his friends that one who had suffered in health should be able to accomplish so much in so many branches of life, and never show any signs of weariness. Any one of the above gifts would have brought a man respect, honor, and admiration, but to those who knew him there was an even greater characteristic, and that was his personal courage. A short time ago all were distressed to hear of his serious illness; from this he recovered and in a short time was back at full work. There was never any suggestion of limiting his activities. He still traveled over long distances to his various meetings and was always cheerful and active. When a short time ago he found he was suffering from a serious disease he faced it with great fortitude and up to the time of his operation discussed general problems impersonally and enthusiastically. Nearly twenty-five centuries ago Euripides said "Take the chance of dying nobly while yet you may lest in a short time death indeed come to thee but a noble death no more." Those who knew of Wilkie's end realize that here was a man who set a fine example of how to die nobly. A great and noble character has left us but there are very many in whose hearts he will live forever.

JAMES WALTON.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE Editor wishes to correct the last paragraph of the review of Dr. Cushing's *Meningiomas*,[1] which appeared in the December, 1938, issue, page 834, to read:

"Written in a charming style, the material and statistics arranged in an interesting manner by Dr. Eisenhardt, the reader does not need to be a neurological surgeon to follow the story with profit to his surgical soul."

THE textbook entitled *Massage and Remedial Exercises*[2] can be recommended as a textbook on massage and exercises for physical therapy technicians. Under each subject the author gives a digest of the pathology and symptoms, and the medical or surgical treatment. The physical treatment by massage, movements, and exercise is considered in detail. The illustrations are excellent. The print is small so the volume contains a mass of information. The book should be useful to the general practitioner too as it gives information on the use of massage and exercise. J. S. COULTER.

THE morphology of arteriosclerosis, with emphasis upon the vascularity of the vessel wall and its relation to the disease manifestations of the intima, is presented by Winternitz, Thomas, and Le Compte in their recent book.[3] By various processes of clearing the walls and injection of the blood channels, the vessel walls as well as changes in the walls themselves become apparent. As expressed by the authors, this material is presented with the hope that the prevalent conception of arteriosclerosis as a degenerative process will be replaced by an understanding of the vessel wall as similar to any other organ of the body in that it may be the seat of acute exudations, hemorrhage, or proliferative reactions which may undergo a whole series of morbid alterations. The observation that the most vascular areas of the vessel wall are those adjacent to the origin of branches, that intramural hemorrhage occurs most frequently in these areas, and also that these same areas are the most frequent site of arteriosclerotic processes, stimulated the desire to investigate a possible causal relationship. Studies were made of the embryological development of blood vessels in order to determine the source of the new vessels which occur in disease processes. The vascularity of vessels in health and disease as well as the differences in various age groups was demonstrated and contrasted with that in several species of animals. The pathological changes in the heart valves in endocarditis were found to be strikingly similar to the arteriosclerotic process in the vessels and the question was raised as to a common etiology. The anastomotic connections between the various vasa vasorum and the ability of the vasa to increase in size make possible the maintenance of blood flow through the mural channels when the lumen of the blood vessel is occluded or narrowed.

It is obvious that an immense amount of careful work preceded the publication of this book. It is concise and well expressed. Each point brought out is illustrated from various angles. Most of the illustrations, which consist of drawings as well as photomicrographs, are in color and are truly remarkable. The concept of the blood as an organ richly supplied throughout with blood vessels of its own opens a new vista in the study of vascular disease.

Not only is the concept of vascular disease greatly advanced by this splendid piece of work but the authors and publishers are to be commended for the beautiful presentation of the material.

M. HERBERT BARKER.

IN this country, McPheeters[4] is a pioneer in the injection treatment of varicose veins, and his monograph on the subject has proved a practical guide for those who are interested in this type of therapy. Almost a decade has elapsed since his book first appeared, during which time a vast amount of work has been done in response to the stimulus offered by the injection treatment. The most significant developments have been the search for better sclerosing agents, and increased emphasis upon the hydrodynamic problems involved in varicose veins. The latter has resulted in insistence upon high saphenous ligation as a preliminary to injection in selected types of cases. McPheeters has kept abreast of these changes in his new monograph. Like most of the other workers in this country, he has adopted solutions of salts of the fatty acids as the preferred sclerosing media. A chapter on preliminary ligation of the saphenous vein has been included. In addition, there is a discussion of the causes of failure following injection, the principal ones, according to the author, being inaccurate diagnosis, inexact technique, and failure to ligate when ligation is indicated. The chapter on the treatment of varicose ulcers has been rewritten with amplification of the author's

[1] MENINGIOMAS: THEIR CLASSIFICATION, REGIONAL BEHAVIOR, LIFE HISTORY AND SURGICAL END RESULTS. By Harvey Cushing, M.D. With the collaboration of Louise Eisenhardt, M.D. Springfield, Ill. & Baltimore, Md.: Charles Thomas, 1938.

[2] MASSAGE AND REMEDIAL EXERCISES; IN MEDICAL AND SURGICAL CONDITIONS By Noel M. Tidy. 3d ed. Baltimore: William Wood & Co., 1937.

[3] THE BIOLOGY OF ARTERIOSCLEROSIS. By M. C. Winternitz, M.D., R. M. Thomas, M.D., and P. M. Le Compte, M.D. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1938.

[4] INJECTION TREATMENT OF VARICOSE VEINS AND HEMORRHOIDS. By H. O. McPheeters, M.D., F.A.C.S., and James Kerr Anderson, M.D., F.A.C.S. Philadelphia: F. A. Davis Co., 1938.

method of sponge compression. Included in the present volume is a brief, straightforward discussion of the injection treatment of hemorrhoids by James K. Anderson. The injection treatment of varicose veins is here to stay, and McPheeters' monograph will continue to serve as a practical guide to those interested in the method. LEO M. ZIMMERMAN.

THE volume of 300 pages by Albert Edward Schlanser[1] is a short, concise manual on diseases of the ear, nose, and throat intended for use in the regular army and is based on many years of experience and observation in peace time. The work is essentially clinical and consequently detailed symptomatology, anatomy, and physiology are purposely omitted.

The book is composed of six chapters dealing chiefly with the patient's complaints followed by a short dissertation on diagnosis and treatment. There are 81 illustrations.

Obviously, it is impossible to condense into 300 pages all the work in otolaryngology but it will enable one to handle confidently and expeditiously each of the many complaints occurring in routine army practice. The student and civil practitioner would find it of doubtful value. JOHN F. DELPH.

THE seventeenth volume of a series of research publications of the Association for Research in Nervous and Mental Disease[2] is made up of the proceedings of the meeting of the Association held in New York on December 28 and 29, 1936.

Like the preceding volumes of this series, this book presents an imposing list of contributors, all of them men in the first rank of American anatomists and neurologists. Five chapters on the anatomy of the pituitary gland, 22 chapters on its physiology, and 15 chapters on general considerations of clinical importance, indicate the comprehensive scope of this work, and it embodies a complete summary of the significant recent advances in our understanding of the hypophysis and its relation to the rest of the organism.

The introductory chapter, by Frederick Tilney, on the various glandular components of the brain, is indeed classical in its treatment. Not only does it present the origin and functional meaning of the various "roof" and "floor" glands, but the origin and nature of the individual hypophyseal components down through the various phyla are described with a clarity and simplicity difficult in the handling of such a subject. A short chapter by Oscar Riddle on "prolactin" will no doubt serve to dispel certain existing false concepts of this hormone, and he has indicated the apparent potential clinical usefulness of this substance. Wayne J. Atwell, in a discussion of the enigmatic pars tuberalis, is unable to assign any physiological function to this portion of the hypophysis, though morphological studies indicate some presumptive evidence of function. The chapter on pituitary basophilism by Irving Pardee, together with the section on pituitary cytology by A. E. Severinghaus, adds much valuable data concerning this interesting disease entity, in which there has been, since 1932, an ever widening field of anatomical and clinical research. There is a concise but complete discussion of acromegaly by Tracy J. Putnam and Leo M. Davidoff.

The material in this book is well balanced, and almost all of it is of direct practical value. It should do much toward the stabilization and correlation of the constantly increasing maze of information relative to the endocrine system. JOHN MARTIN.

THE popularity of *Electrotherapy and Light Therapy*[3] by Kovács is demonstrated by the demand for a third edition within 5 years of its original appearance. The new edition has been thoroughly revised and much new material has been included to bring down to date the knowledge concerning this field. In general the illustrations are well selected, but the many illustrations of various machines could well be replaced by further illustrations of technique.

The book presents the physics, the apparatus, the physiological effects, the indications and contraindications for electrotherapy. The chapters on electrophysics, galvanic current, and electrosurgery have been revised. There have been added new chapters on the relation of electrophysiology to electrotherapy, on short wave diathermy, and on artificial fever by electrical means.

The physics of radiant energy, the physiological effects of the various forms of infrared, visible and ultraviolet radiation, and their clinical applications are also presented. The volume is orderly in arrangement, concise, and sound. It can be recommended to physicians as the best textbook on these subjects.

J. S. COULTER.

[1] PRACTICAL OTOLOGY, RHINOLOGY AND LARYNGOLOGY. By Albert Edward Schlanser, M.D. Philadelphia: Lea & Febiger, 1938.

[2] THE PITUITARY GLAND; AN INVESTIGATION OF THE MOST RECENT ADVANCES. Vol. 17 of a Series of Research Publications by the Association for Research in Nervous and Mental Disease. Baltimore: The Williams & Wilkins Co., 1938.

[3] ELECTROTHERAPY AND LIGHT THERAPY. By Richard Kovács, M.D. 3d ed. Philadelphia: Lea & Febiger, 1938.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

CANCER; ITS DIAGNOSIS AND TREATMENT. By Max Cutler, M.D., and Franz Buschke, M.D. Assisted by Simeon T. Cantril, M.D. Philadelphia and London: W. B. Saunders Co., 1938.

SPINAL ANESTHESIA. By Louis H. Maxson, A.B. Foreword by W. Wayne Babcock, M.D., LL.D., F.A.C.S. Philadelphia, London, New York, Montreal: J. B. Lippincott Co., 1938.

PHYSICAL DIAGNOSIS. By Richard C. Cabot, M.D., and F. Dennette Adams, M.D., 12th ed. Baltimore: William Wood & Co., 1938.

THE SURGERY OF ORAL AND FACIAL DISEASES AND MALFORMATIONS; THEIR DIAGNOSIS AND TREATMENT, INCLUDING PLASTIC SURGICAL RECONSTRUCTION. By George Van Ingen Brown, D.D.S., M.D., C.M., F.A.C.S. 4th rev. ed. Philadelphia: Lea & Febiger, 1938.

PHYSIOLOGY OF THE NERVOUS SYSTEM. By J. F. Fulton, M.A., D.Ph. (Oxon.), S.B., M.D. London, New York, Toronto: Oxford University Press, 1938.

MARIHUANA; AMERICA'S NEW DRUG PROBLEM. A SOCIOLOGIC QUESTION WITH ITS BASIC EXPLANATION DEPENDENT ON BIOLOGIC AND MEDICAL PRINCIPLES. By Robert P. Walton. With a Foreword by E. M. K. Geiling. Philadelphia, London, Montreal, Chicago, and New York: J. B. Lippincott Co., 1938.

PRACTICAL BIRTH-CONTROL METHODS. By Norman E. Himes, Ph.D., with the medical collaboration of Abraham Stone, M.D. Introduction by Robert L. Dickinson, M.D. Foreword by Havelock Ellis. New York: Modern Age Books, 1938.

SOCIAL HYGIENE NURSING TECHNIQUE. A MANUAL OF PROCEDURE IN THE DIAGNOSIS, TREATMENT AND PUBLIC HEALTH CONTROL OF SYPHILIS AND GONORRHEA. By Nadine B. Geitz, M.A., R.N. New York: American Social Hygiene Ass., 1938.

CLINICAL LABORATORY METHODS AND DIAGNOSIS; A TEXTBOOK ON LABORATORY PROCEDURES WITH THEIR INTERPRETATION. By R. B. H. Gradwohl, M.D. 2d ed. St. Louis: The C. V. Mosby Co., 1938.

THE FUNCTIONS OF HUMAN VOLUNTARY MUSCLES. By Norman D. Royle, M.D., Ch.M., F.R.A.C.S. Sydney and London: Angus & Robertson Ltd., 1938.

CONTROL OF CONCEPTION. By Robert Latou Dickinson, M.D., F.A.C.S. 2d ed. Medical Aspects of Human Fertility Series Issued by the National Committee on Maternal Health. Baltimore: The Williams & Wilkins Co., 1938.

CLASSIC DESCRIPTIONS OF DISEASE; WITH BIOGRAPHICAL SKETCHES OF THE AUTHORS. By Ralph H. Major, M.D. 2d ed. Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1939.

ANATOMIA DE NEONATO. By Francesco Bellelli. Preface by Prof. Sen. Giunio Salvi. Naples: G. U. F. "Mussolini" Sezione Editoriale, 1938.

THE PHYSIOLOGY OF ANESTHESIA. By Henry K. Beecher, A.B., A.M., M.D. London, New York, Toronto: Oxford University Press, 1938.

PATHOLOGISCHE PHYSIOLOGIE CHIRURGISCHER ERKRANKUNGEN (Experimentelle Chirurgie). First 3 editions edited by Franz Rost. 4th ed. Edited by F. K. Kessel, F. Merke, F. Meythaler. Part 1.—VERDAUUNGSORGANE. Edited by Th. Naegeli. Berlin: Julius Springer, 1938.

Engraving by E. Scriven

William Harvey

1578-1657

UNIV. OF MICH.